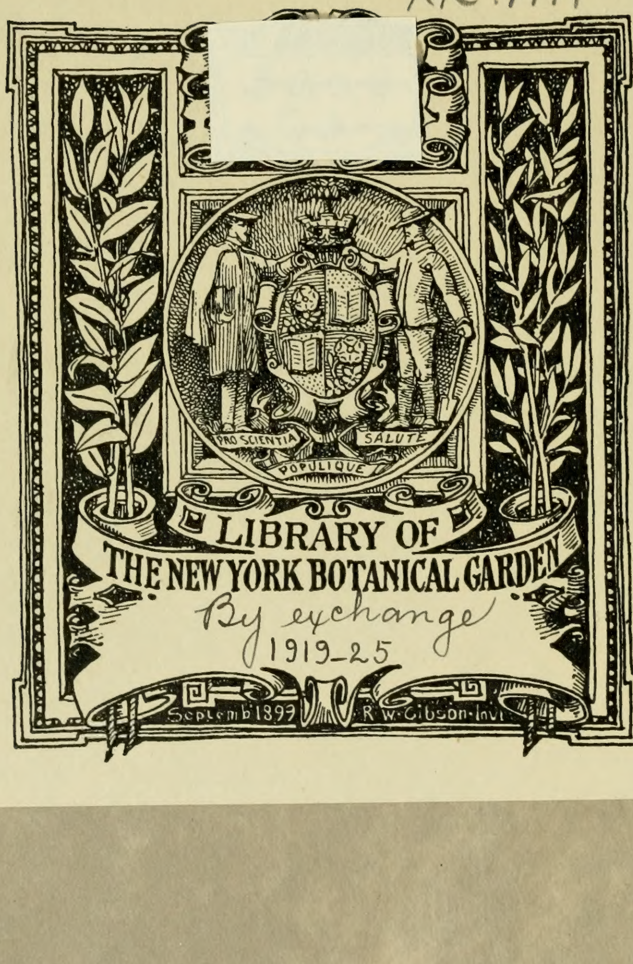
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TWELFTH ANNUAL REPORT

OF THE

Quebec Society for the Protection of Plants from Insects and Fungous Diseases

1919-1920

SUPPLEMENT TO THE REPORT OF
THE MINISTER OF AGRICULTURE

PRINTED BY ORDER OF THE LEGISLATURE

L. A. PROULX, KING'S PRINTER
QUEBEC
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To the Honourable J. E. Caron, M.P.P.,

Minister of Agriculture,

Quebec.

Sir :—

I have the honour to present herewith the twelfth Annual Report of the Quebec Society for the Protection of Plants from Insects and Fungous Diseases, containing the proceedings of the winter meeting of the Society, which was held at Macdonald College, Ste. Anne de Bellevue, Que., on the 17th of March, 1920.

Included are the papers that were read, and the reports of the officers of the Society.

I have the honour to be,

Sir,

Your obedient servant,

B. T. DICKSON,

Secretary-Treasurer.

Macdonald College, Quebec.

OFFICERS FOR 1920-1921.

President—Professor W. Lochhead, Macdonald College.

Vice-President—Rev. Father Leopold, Oka Agricultural Institute, La Trappe, Que.

Secretary-Treasurer—Prof. B. T. Dickson, Macdonald College.

Curator and Librarian—P. I. Bryce, Assistant in Biology, Macdonald College.

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A. F. Winn, Esq., Montreal.
Rev. Prof. Fontanel, St. Mary's College, Montreal.
G. Maheux, Provincial Entomologist, Quebec.
G. Chagnon, Esq., Montreal.
Prof. G. Bouchard, Ste. Anne de la Pocatiere.

Auditor—E. M. DuPorte, Macdonald College.

Delegate to the Royal Society of Canada.—Prof. W. Lochhead, Macdonald College.

Delegates to the Ontario Entomological Society.—Prof. Letourneau or Rev. Father Leopold and H. Roy or Prof. Bouchard.

Delegates to the Canadian Branch of the American Phytopathological Society.—Rev. Father Leopold or Prof. Letourneau and Prof. Lochhead or Prof. B. T. Dickson.

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Bedard, Avila	Forestry Service, Quebec
Blair, W. Saxby	Kentville, N.S.
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Bouchard, Prof. Geo.	Ste. Anne de la Pocatiere
Brittain, Prof. Wm. H.	Agric. College, Truro, N.S.
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Buckle J. L.	Montreal
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Charron, Dr. A. T.	St. Hyacinthe, Que.
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Cummings, R. F.	330, First Ave., Maisonneuve
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Fyles, Rev. Dr. Thos. W.	368 Frank St., Ottawa
Gibb, L.	148 St. James St., Montreal
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Gorham, A. C.	Fredericton, N. B.
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Gosselin, Charles	Ft. Coulonge, Que.
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Guenette, L.	Forest Service, Quebec
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Hetherington, S. J.	Macdonald College
Hockey, J. F.	Macdonald College
Honore, Rev. Father	La Trappe, Que.
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Jenkins, M. H.	Ottawa, Ont.
Keating, Rev. Prof.	Loyola College, Montreal
Kieffer, H. F.	Forest Service, Quebec
Lavoie, J. H.	Horticultural Bureau, Quebec
Leopold, Rev. Father	La Trappe, Que.
Levasseur, Rev. Paul	Ste. Anne de la Pocatiere
Lloyd, Prof. F. E.	McGill University, Montreal
Lochhead, Prof. W.	Macdonald College
MacClement, Dr. W. T.	Queen's University, Kingston, Ont.
Maheux, G.	Provincial Entomologist, Que.
Major, T. G.	Macdonald College
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Menard, J. H.	Forestry School, Berthierville
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Newton, Dorothy	Senneville, Que.
Nolet, Louis	College de Levis, Levis, Que.
Pasquet, Jos.	Ste. Anne de la Pocatiere
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Petraz, Mr.	Hortic. Service, Que.
Piché, G. C.	Chief Forester, Quebec
Reid, Peter	Chateauguay Bassin, Qué.
Rankin, Dr. W. H.	St. Catherines, Ont.
Reynaud, Mr.	Berthierville, Quebec
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Roy, H. B.	Sudbury, Ont.
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Simard, J.	Dept. of Agr., Quebec
Simmonds, P. M.	Macdonald College
Southee, G. A.	356 Durocher St., Outremont
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Stohr, Rev. L. M.	Ironside, Que.
Strickland, E. H.	Dept. of Agr., Ottawa
Summerby, R.	Macdonald College
Swaine, Dr. J. M.	Entomological Branch, Dept. of Agr., Ottawa
Tessier, G.	Forest Service, Quebec
Victorin, Rev. Bro.	Longueuil, Que.
Willey, Prof. A.	58 Metcalfe St., Montreal
Winn, A. F.	32 Springfield Ave., Westmount

HONORARY MEMBERS

James W. Robertson, Esq., LL.D., C.M. G., Ottawa
Hon. J. E. Caron, M.P.P., Quebec.
F. C. Harrison, D.Sc., Macdonald College.
Rev. Father Superior, La Trappe.
Auguste Dupuis, Village des Aulnaies.
Hon. Jules Allard, M.P.P., Quebec.
Canon V. A. Huard, D.Sc., Quebec.
Rev. Father Superior, Ste. Anne de la Pocatiere.

FINANCIAL STATEMENT FOR 1919-20

Receipts

Brought forward	$142.60
Provincial Govt. cheque	250.00
Interest on deposit	6.93
	$399.53

Disbursements

Expenses of lecturers and members at Annual Meeting	$ 58.70
Expenses of delegates to Ont. Entom. Soc.	14.00
Expenses of delegate to Can. Phytopath. Soc.	25.00
Investigations and Inspection	50.00
Separates	49.75
Express, postage and clerical assistance	24.50
Secretary	50.00
	$271.95
Balance in the Bank, May 10th, 1920	127.58
	$399.53

Auditor:—
E. MELVILLE DUPORTE.

B. T. DICKSON,
Sec.-Treasurer.

W. LOCHHEAD,
President.

QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS FROM INSECTS AND FUNGOUS DISEASES

REPORT OF THE WINTER MEETING

The twelfth annual meeting of the Quebec Society for the Protection of Plants was held in the Biology Building, Macdonald College on Wednesday March 17, 1920.

Business Meeting

The business meeting was opened by Prof. Lochhead at 2.00 p.m. Among those present were:—Father Leopold, Vice-President; Dr. J. C. Chapais, Geo. Maheux, Dr. Charron, Professeur Letourneau, A. F. Winn, Professor Lloyd, Professor Dickson, Mr. C. E. Petch, Mr. F. L. Drayton, Mr. C. B. Hutchings, Mr. Buckle, Rev. Dr. Campbell and many others.

The minutes of the last annual meeting as given in the 11th. Annual Report were approved.

The report of the Treasurer was read and accepted. The following officers were elected for the ensuing year:—

President—Professor W. Lochhead, Macdonald College.

Vice-President—Rev. Father Leopold, La Trappe.

Sec.-Treasurer—Prof. B. T. Dickson, Macdonald College.

Curator-Librarian—P. I. Bryce, Macdonald College.

Directors:

Rev. Dr. T. Fyles, Ottawa.
Prof. Letourneau, La Trappe.
A. F. Winn, Esq., Montreal.
Rev. Prof. Fontanel, St. Mary's College, Montreal.
G. Maheux, Provincial Entomologist, Quebec.
G. Chagnon, Esq., Montreal.
Prof. G. Bouchard, Ste. Anne de la Pocatière.
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Delegates to the Canadian Branch, Phytopathological Society—Rev. Father Leopold or Prof. Letourneau, Prof. Lochhead or Prof. Dickson.

It was resolved that the Society, so far as funds are available, continue to help in aiding investigations concerning entomological and phytopathological questions.

The following resolution was passed by the Society:—

"That this meeting of the Quebec Society for the Protection of Plants place on record its appreciation of the sterling worth, the deep knowledge and high ideals of Dr. C. Gordon Hewitt, and its sorrow at losing by death a member so universally respected, and that a copy of this resolution be forwarded to his widow with the condolences of the Society".

The Secretary was instructed to forward a copy of the above to Mrs. C. G. Hewitt.

It was reported that the work on the Hemiptera or Part IV of the List of the Insects of the Province of Quebec was still is process of preparation and nearing completion.

It was decided that the Summer meeting for 1920 be held in conjunction with that of the Pomological Society at Aylmer, Que.

GENERAL SESSION

The general session of the Twelfth Annual Meeting was opened at 3.15 p.m. in the Biology Building by the President, Prof. Lochhead.

Dr. Harrison, Principal of Macdonald College, extended a cordial welcome to the Society. The addresses and papers are printed in detail in the body of the Report. The evening lecture was given by Prof. F. E. Lloyd, Prof. of Botany, McGill University. Prof. Lloyd is an expert on Rubber, and his illustrated lecture dealing with a recent trip to Java and Sumatra was thoroughly enjoyed by the Society and by the many visitors.

SUMMARY OF ADDRESS OF WELCOME TO THE QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS, MACDONALD COLLEGE, MARCH 17th, 1920, BY Dr. HARRISON.

I am very pleased indeed to be able to welcome our friends from La Trappe, Dr. Chapais, the Entomologistsfrom Ottawa and those interested in the Protection of Plants.

Since your meeting last December here, there has passed away one who had a great interest in this Society and who frequently was present at its meetings, a man who with his training and executive abilities has made a great impression on Entomology throughout Canada. I refer to the death of Dr. C. Gordon Hewitt. I think the majority of you here have known Dr. Hewitt. With his charming personality and his very deep knowledge of

entomology he was an enthusiastic administrator. As a writer of books and of many articles during the course of his somewhat short and brilliant career, he has left an impression on the entomological world and particularly in Canada. His untimely death at the early age of thirty-five is greatly lamented. During the time he had charge of the Entomological Branch, I think the branch has moved forward in leaps and bounds with the organization which he carried on in the various provinces and the work of bringing the importance of entomology to the attention of the public. In the Royal Society of which he was Treasurer, his opinions were always asked for and respected, and although it is hardly my business, I hope that this Society will pass a resolution to send a note of sympathy to his widow.

You will pardon me, I am sure, referring to this in the address of welcome, but I feel that a testimony of appreciation of Dr. Hewitt's work should be recognized.

I do not intend to take up any more of your time. It is rather late in the afternoon and you have an extensive program before you and this is only a one day meeting. I am sure that your meetings will be of great benefit to you. We always have a number of students here interested in Entomology and I am sure that they recognize the opportunity of hearing a number of our friends whom your president has brought out for this meeting.

I wish your Society every success.

THE PRESIDENT'S ADDRESS

THE NATURAL CONTROL OF INSECTS.

W. Lochhead, Macdonald College.

It would almost appear as if Entomologists and Chemists have reached an Aisne line with regard to the control of insects by artificial means. Our spraying mixtures and devices have been developed during the last twenty-five years to such an extent that it is hardly probable that much improvement in these directions will be made. Some changes will be made without doubt in the method of preparation of some of the chemicals used in spraying and some new chemicals, and some improvements will be introduced, but these I surmise, will be of minor importance.

It seems to me that the next great forward step, and the most difficult one, of the economic entomologist must be in the direction of the better utilization of the natural agencies in the control of the injurious insects that cause enormous losses in spite of the wonderful development of the artificial methods in recent years.

To the average layman and others uninitiated into the mysteries of insect life, this method has appealed very strongly, but they fail to realize the great difficulties that stand in the way of a general adoption of such a method. Their imagination has been fired by the successes that attended a few isolated cases,

such as the control of the cottony cushion-scale of California by the introduction of the *Novius cardinalis* lady-bird from Australia, and of the black scale of the olive by the *Scutellista* chalcid from South Africa. They have either forgotten or have not heard of the many partial successes and absolute failures.

The reasons why the natural method of control has not had more cases of success are the extreme complexity of most of the problems, the lack of sufficient knowledge of the factors that operate, and the difficulty of devising measures of control.

The natural agencies of control may be grouped into four:

1.—Climate.
2.—Food supply.
3.—Predatory animals.
4.—Parasitic animals and plants.

Climate: The effects of changing and unnusual conditions of heat and cold, snows and rains, humidity and dryness, and other seasonal changes have long been known to be important factors in regulating the number of insects.

A variable winter is more fatal to most forms of insect life than a continuously severe or a continuously mild winter. When insects go into hibernation they become torpid and are able to resist quite low degrees of cold, but if thaws occur they may become partially active for a short time. With every change of this nature the insect loses vitality and this loss may prevent transformation in the spring. Moreover, the effects of thaws in breaking up larval and pupal cells in the ground are often quite marked.

Sudden changes of temperature of say 30° range within a few hours, which are quite common in our latitude, are very fatal to aphids and many caterpillars during their early stages.

Another feature of the environment of insects is the different degree of humidity demanded by each species or genus. Some insects like the thrips, chinch bug, wheat midge and red spiders are more abundant under dry conditions, while other insects like the plant and Hessian fly develop best under moist conditions.

Observations seem to show that climatic changes are often fatal to those insects that are living on the fringe of their distributional range. Under favorable conditions some insects may migrate northward and even do much damage, but such movements may be termed *incursions*, and are temporary and spasmodic in their character. For example, the San José scale appeared in this locality some years ago but its presence has not been noted since.

Again, the San José scale was for many years an aggressive insect, multiplying rapidly under natural conditions on its numerous food plants, south of the latitude of Quebec. During the severe winter of 1917-18, however, a large percentage of the scales was killed over large areas in New York State and Southern Ontario. So far as can be observed, the only factor that operated more trongly than usual was that of low temperature conditions which lasted for a longer period than usual.

Regarding the action of the climatological factors on insect life a few facts have been ascertained. Bachmetjew, a Bulgarian, determined the effect of varying temperature and humidity on the metabolic activities of several insects. Humidity modifies the effects of temperature; there is an optimum humidity for metabolism, not only for each species but for each stage of each species and for each stage of each individual. Pierce found that the optimum temperature and humidity for the boll weevil are 83° F. and 65° F. respectively.

Ewing found that the development of *Aphis avenae* is prevented at a constant temperature of 90° F., and that the optimum temperature for the production of wingless agamic forms is about 65° F.

Food Supply: This is a factor of considerable importance as most insects tend to multiply rapidly when the supply of food is abundant, and to decrease when the supply is scarce. Without wheat there would be no wheat midge, and the practical elimination of certain forest trees has brought about the disappearance of their insect pests.

Some insects feed upon but a single kind of plant, and if the range of cultivation of this plant be extended the insects will also extend their range. They are apparently hardy enough to withstand different climatic conditions. An excellent illustration of an insect of this kind is the cotton boll weevil. It is apparently a potential enemy as far north as cotton will grow.

Man by clearing forests and making farms where enormous areas of certain crops are grown has made conditions favorable for the development of the insects that feed upon these crops.

Predatory Animals: These are also an important factor that requires more emphasis. First among these are insectivorous birds. In an address to this Society five years ago on "The Web of Life", I stated as follows:—

"Facts which convince even the most sceptical are accumulating regarding the valuable role played by birds in the control of noxious insects. Studies of bird diets prove conclusively that the majority of our common birds feed mainly upon insects. Forbes of Illinois states after a careful study of the contents of the stomachs of birds that about two-thirds of the food of birds consists of insects. Well-informed writers tell us that without birds the earth would be uninhabitable after six years, and yet man in his ignorance is constantly destroying these valuable friends, simply because he finds that they levy an insignificant toll on his fruits and grains. It is possible that we would be better off if certain birds were greatly reduced in numbers, but of this we are not absolutely certain, for the web of life is most complex, and no person knows how far-reaching the results would be.

"Aside from the fact that birds aid very materially in reducing the numbers of insects when they come as scourges, it is very important to remember that birds nip many incipient scourges in the bud. Their mobility and varied character and habits enable them to move rapidly from place to place and thus maintain the

balance of nature which man is always tending to upset. Even in wild nature the balance is never quite complete; at best the equilibrium is unstable.

"It is very interesting that the two great classes of successful fliers should be, in the wide economics of Nature, fitted against one another, wings against wings, freeman against freeman, invertebrate against vertebrate, "little brain" against "big brain", "instinct" against "intelligence". Practically this is the most important conflict of classes that the world knows"—(Thomson).

Among other well-known enemies of insects are toads, skunks and snakes, which are too frequently killed on sight. Mr. Norman Jack, the well-known and well-informed horticulturist of Chateauguay Basin, sent me a letter, received too late for the Annual Meeting, containing the following important suggestions:

"First,—due to the indiscriminate trapping and destruction of foxes, and skunks, in the fruit growing sections, field mice and destructive rodents have become much more plentiful, and the probability is that there will be found many trees girdled, or partly destroyed, when the snow is gone. How little the general public realizes that one of the fruit growers' best friends, by keeping crickets and white grubs in check, is the much despised pole-cat or skunk. The writer hopes that in the near future there will be legislation brought in whereby there will be a closed season, if not a complete protection, for these two orchards friends.

"Second,—a further suggestion which the writer would make is that the laws relating to the protection of bird-life be more widely diseminated and that copies be sent to the authorities of every Agricultural Society in the province, and also to the heads of Municipal Councils of towns, villages, etc. and also if possible to every Justice of the Peace.

"Third,—another item which in the writer's opinion should be considered is that of compulsory care of orchards. One has only to take a trip into Montreal to notice along the way the many neglected apple trees which are a menace to every orchard for many miles. The writer cannot see the moral right whereby a party can neglect a fruit orchard and permit it to infest the country with disease and insect pests, and not try to remedy it, any more than one should be permitted to allow noxious weeds to flourish, without some attempt to control or destroy them, or a cattleman to keep a herd of diseased cattle. The owners should be *compelled* to care for their trees properly, or cut them down and burn them. This no doubt will appear to be drastic measures but it is only by some such drastic action that we can bring the neglectful owners to a realization that in a measure they must be responsible for their neglected trees."

There are, moreover, many predaceous insects that kill large numbers of injurious forms. The lady-birds feed almost entirely on plant-lice and scale insects; the ground-beetles on cut-worms, canker-worms and other caterpillars, and on many injurious grubs in or on the ground; some of the Hemiptera and other insects are also predaceous.

Parasitic Animals and Plants. The part played by parasites is very important. They may be grouped into (a) *parasitic insects,* such as the chalcids.

proctotrypids, ichneumonids, braconids, tachinids and syrphids;

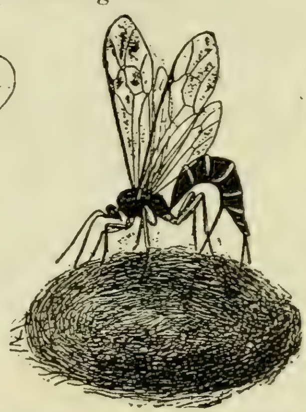
(b) Probably *parasitic protozoa*, such as the diseases of the gypsy caterpillar, the silk-worm, the cabbage-worm, the army-worm and many others;

(c) *Predaceous mites*, such as *Hemisarcoptes;* and

(d) *Parasitic bacteria and fungi*, such as *Coccobacillus* of locusts, *Sporotrichum* of Chinch-bugs, *Sphaerostilbe* of the San José Scale, *Empusa* on flies, crickets and plant lice, *Cordyceps* on white grubs and wireworms, and others, which sometimes cause epidemics.

Another factor in the natural control of injurious insects in forests has been brought out by several observers, and that is that many of these insects do not become epidemic in forests of mixed growth. Tothill tells us that in New Brunswick the Budworm has gained no foothold in areas where the Balsam Fir exists in the primeval condition of mixed growth.

Pteromalus puparum a chalcid parasite of Chrysalids of the Cabbage Caterpillar.



Pimpla Conquisitor ovipositing on a cacoon of the tent-caterpillar. (After Fiske)

A parasitic tachina-fly and its puparum. (After Weed)

Certain farm insects can be most effectively controlled by plowing under infested stubble. This applies especially to the joint worms of wheat, rye and barley and to the Hessian Fly. As these crops are often used as nurse crops for clover the practicability of such a procedure is out of the question, unless a change can be made in the ordinary rotation of crops. It would appear then as if a new system of rotation should be devised by expert agronomists to meet the situation.

We have frequently observed that many of our most conspicuous pests like the Tent caterpillar and the Tussock Caterpillar appear in cycles separated by a period of years. Their disappearance after serious outbreaks is attributed to the work of parasites. But may there not be other factors operating? The matter has never been thoroughly investigated in a scientific manner. Not until all the factors are known and studied can we hope to prevent the periodic outbreaks that do much damage.

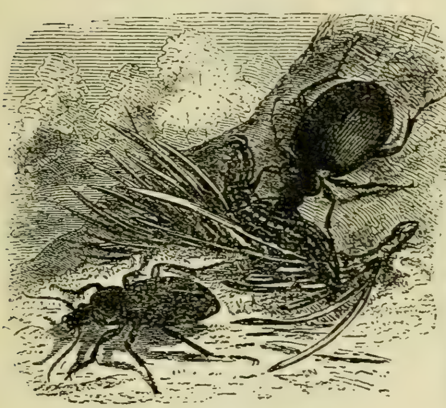
Again, in this region, the Cherry-tree Tortrix was more abundant than usual during July of 1919 on wild and choke cherries. An analysis of the situation seems to point to the relative absence of its normal parasites as the main reason for its abundance.

Many other examples might be given but these will suffice to show that the lethal factors in most of the cases are beyond man's control.

Mr. Petch informs me that the Squash bug (*Anasa tristis*) was very abundant about Hemmingford, some fifty miles south of Montreal, yet I have never seen a live specimen on the Island of Montreal, where its food plant is very abundant. I cannot give any satisfactory explanation for its presence in one case and its absence in the other.

It is very apparent that our knowledge of the real nature of the actions of the various natural factors of insect control is wofully deficient.

Mr. J. D. Tothill of the Dominion Entomological Laboratory, Fredericton. N. B., has made some interesting studies of the control factors that operated in 1912-15 in New Brunswick on the Forest Caterpillar (*Malacosoma disstria*) and the Fall Webworm (*Hyphantria sp*), published in the Annual Report of the Entomological Society, Nova Scotia, 1918.



A ground-beetle (**Calosoma sp.**) feeding on cutworm; below, a species of **Carabus.** (After Brehm)

Caterpillars killed by a bacterial disease. (After Washburn)

His observations showed that on the average chicadees and mites destroyed 50 of the 200 eggs in the egg-mass of the Forest Caterpillar, *egg parasites* destroyed 15, starvation killed 67 of the first stage caterpillars, ants killed 51 caterpillars of the 2nd, 3rd, and 4th stages, and *parasites* killed 13 caterpillars and 3 pupae. On the average only 14 adults survived out of 2000 eggs laid the previous season by 10 females. On the supposition that half of the survivors were females; the reduction would be only 30 percent in spite of the very heavy mortality.

In 1914, there was no starvation and no reduction by ants, consequently a great increase in caterpillars occurred, and the egg masses were so numerous that a scourge of caterpillars in 1915 was looked for, but a light frost occurred in 1915 during the first stage of the young caterpillars, with the result that practically all of them were destroyed. In 1916, they were so rare that they could not be found.

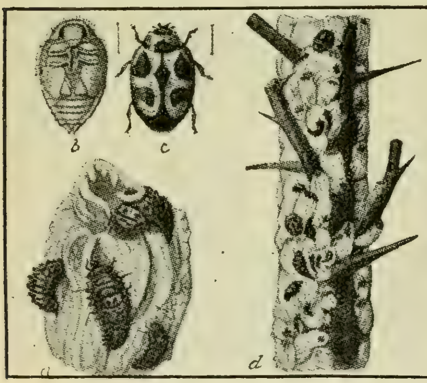
Mr. Tothill's studies of the Fall Webworm for six years (1912-1917) show that about 10 percent of the egg-mass of 300 do not hatch. In 1912, the parasites

were mainly responsible for the reduction in numbers, but for the last five years the webworms became scarce. The parasites died out and the birds became the most important factor of control. Mr. Tothill pointed out that just when the webworms were at the point of extinction a southeast wind brought in a flight of webworm moths from Nova Scotia, with the result that these have greatly increased since their parasites are few in number.

He points out also that the 1917-1918 outbreak of Fall Webworms in Nova Scotia was due to the scarcity of two parasites *Varichaeta* and *Limnerium,* which were abundant in 1912 in New Brunswick, and that if measures had been taken in 1912 to introduce these parasites into Nova Scotia, the outbreak could have been prevented.

Mr. Tothill also cites the case of a heavy isolated outbreak of Forest Caterpillars at Red Deer, Alberta, in 1917-18. An examination failed to find a single parasite, and he believes that if precautions had been taken four years before to introduce its two chief parasites, *Limnerium* and *Blepharipeza,* from the Atlantic board or the Provinces where they were abundant, the outbreak could probably have been prevented.

Sphinx caterpillar with cocoons of braconid parasites.



Australian ladybird-beetle (**Novius cardinalis**), the enemy of the cottony-cushion scale. (Natural size)
a—lady bird larvae feeding on adult female and egg sac; b—pupa; c—adult ladybird; d—orange twig, showing scales and ladybirds. (After Marlatt, United States Dept. of Agric.)

Early attempts to employ natural methods of control.

Silvestri tells us that the first person to employ successfully parasitic and predaceous insects was Boisgiraud of Poictiers, France. About 1840, he rid the poplars along a promenade in a suburb of his town of the Gypsy moth by introducing the carabid *Calosoma sycophanta,* and he destroyed the forficulids in his garden by using a rove beetle *Staphylinus oleus.*

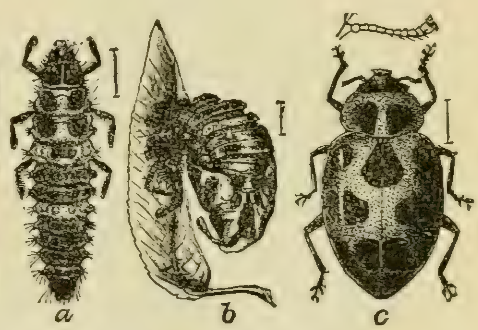
Boisgiraud's successes prompted a Milan Society in 1843 to offer a gold medal to the person who had in the meantime carried out successfully experiments on the artificial breeding of carnivorous insects which may be utilized to advantage for the destruction of other insects injurious to agriculture. Antonio Villa responded with a report dealing with successful experiments he had carried

on at Disio near Milan. Villa employed climbing carabids to destroy all the forms feeding on the plants, staphylinus to destroy insects feeding in flowers, and ground carabids to hunt out all insects that feed at the surface of the ground.

From 1850-1873, Rondani, an Italian, made the most valuable contributions to the study of parasitology. He was of the opinion, however, that parasites were far more important than birds as control factors. He said: "The policing of the fields cannot be entrusted to birds because they are unreliable and kill the guilty with the innocent; they are robbers as well as guardians of the field products, and therefore do not yield the most, and sometimes any calculable advantage, if not, even more farm than good in the very things which were sought to be saved by their means".

Perris and Decaux of France in the seventies and eighties advocated strongly the use of parasites, and Berlese and Del Guercio of Italy later recognized and emphasized the value of entomophagous insects rather than insectivorous birds.

Syrphus flies; 1 and 2, adults; 3, larvae eating plant lice; lower figure contracted larva; 5 and 6, view of larva, enlarged, and pupa.



Lady beetles ("lady birds," "lady bugs") or coccinellids; a—larva; b—pupa; c—imago; all much enlarged. (U. S. Bu. Ent.)

In this connection it is interesting to note Silvestri's own opinion. He says: "I, for my part, believe that the usefulness and the harm of insectivorous birds balance each other and that more frequently the former may be superior to the latter, considering things only from the viewpoint of immediate agricultural interest."

The utilization of parasites for the control of injurious insects has been attempted on the greatest scale in New England in connection with the suppression of the Gypsy and Brown Tail Caterpillars. These pests came to America without their parasites and as the native parasites did not appear to relish them the new arrivals multiplied exceedingly and became a serious menace to shade and forest trees.

Efforts were then made to introduce its foreign parasites, but the difficulties of the task soon became apparent. Besides the labor of gathering sufficient numbers and of transporting them without loss, there was much trouble in sorting

them out and breeding them in large numbers for liberation in infested districts. In addition the "secondary" parasites which were also imported with the "primary" had to be collected and destroyed.

Notwithstanding all these efforts, the authorities in charge of the work are of the opinion that the present improvement is due to at least three other factors, viz. "the perfection and standardization of the methods for artificial repression, the death of a large proportion of the more susceptible trees or their removal from the infested woodlands, and the development of the "wilt disease". Of course, there is the possibility that the imported parasites will in time become sufficiently numerous to hold the pests under control as they do in Europe. This result will be obtained when 85 or 90 percent of the eggs and caterpillars are killed, as the actual rate of increase of the Gypsy moth is from 6 to 10 fold.

It will be evident, therefore, that successful control of injurious insects by parasitic and predaceous forms depends upon several favorable factors and sets of conditions. These have been well summarized by H. S. Smith (Journ. Econ. Ent. Aug. 1919) as follows:—

1.—The reproductive capacity of available entomophagous insects must be much higher than that of the host. This proposition is self-evident, and needs no amplification.

2.—A complete sequence of parasites affecting the egg, larva and pupa of the pest. The importance of this factor was fully shown in the campaign against the Gypsy moth.

3.—The entomophagous forms must be capable of being reared or obtained in sufficient quantities to overcome the pest in the field. This factor is one of the most difficult to bring into operation. Lady-birds are readily reared and collected.

4.—The cost of producing natural enemies must remain well within the bounds of profitable crop production.

5.—Secondary parasites in the local fauna should limit as little as possible, much less entirely prevent, the action of the primary parasites. This factor is also one that is most difficult to control.

6.—Agricultural practices such as spraying and fumigation which affect adversely the breeding of natural enemies should be prevented. It is probable that the extermination of the imported Chinese Lady-bird in southern orchards was due mainly to spraying operations with lime sulphur carried on as a practice.

7.—The relative ability of the pest and its enemies to spread is an important factor. If both be good fliers the power of spreading is increased but the likelihood of extermination of the pest is lessened.

The citrus mealy-bug has been controlled in Southern California by the lady-bird *Cryptolaemus montrouzieri* which was reared in large numbers at the State Insectary and collected in orchards where they had become abundant late in the season. In this instance, as in that of the cottony-cushion scale, the lady-bird is an active insect while the scale insect is fixed to the plant. Moreover, the lady-bird has more generations that the scale insect and is practically free from parasites.

The utilization of fungous and protozoan diseases in insect control. (*)

Many experiments have been conducted within the last thirty years with the object of controlling injurious insects through the artificial production of epidemics of fungous diseases. As in the case of parasitism unexpected difficulties have appeared under field conditions. It was soon discovered that "fungi are very dependent upon external conditions, and in many cases the apparent absence of a particular fungus in a locality is usually an index of conditions unfavorable for its development and an artificial introduction will be useless" (Glaser).

Out of the large number of experiments that have been carried out, I shall briefly refer to a few of the most outstanding ones. Franz Tangl in 1892 used spore emulsions of *Botrytis bassiana* against the caterpillars of the nun moth of Central Europe. While the experiments were eminently successful in the laboratory where all the infected caterpillars died of "muscardine", those carried on outdoors gave negative results. Tubeuf also obtained like results with *Cordyceps militaris.*

Many of us perhaps are familiar with the work of Snow and Forbes in connection with the artificial use of *Sporotrichum globuliferum* against chinch bugs. Later Billings and Glenn also carried on experiments with the same fungus. Their results are summarized as follows:—

1.—"In fields where the natural presence of the fungus is plainly evident, its effect on the bugs cannot be accelerated to any appreciable degree by the artificial introduction of spores. .

2.—"In fields where the fungus is not in evidence spores introduced artificially have no measurable effect.

3.—"Apparent absence of the fungus among chinch bugs in a field is evidence of unfavorable conditions rather than lack of fungous spores.

4.—"Laboratory experiments can be made to prove that artificial infection accomplishes results upon bugs confined in cramped quarters and without food, but in the field, where fresh and usually drier air prevails and food is abundant, an entirely different situation is presented."

In 1912 Morrill and Back experimented with the artificial use of the white fly fungi, *Aegerita webberi, Aschersonia aleyrodis* and *A. flavocinta.* They summarized their conclusions in these words:

1.—"The fungus parasites thrive only under suitable weather conditions during a period of about three months each year; generally speaking the summer months in the case of the two Aschersonias and the fall months in the case of the brown fungus.

2.—"Under natural conditions, without artificial assistance in spreading, the fungi have ordinarily, in favored localities, controlled the white fly to the extent of about one-third of a complete remedy through a series of years.

(*)—European botanists, such as DeBary and Tulasne, about the middle of the last century called attention to the importance of white muscardine (*Isaria densa* Link.) as a check on many insects. Metchnikoff, and Krassilstscik cultivated the green muscardine (*Metarhizium anisopliae* Sorokin) for the control of *Anisoplia* and the beet weevil (*Cleonus punctiventris*).

Efforts have also been made to check the white grub in Europe by means of *Cordyceps melolonthae* Tul., *Isaria densa*, and *Botrytis tenella* Sacc.

3.—"The infections secured by artificial means of introducing fungi, while successful in introducing the fungi, have thus far proved of little or no avail in increasing their efficacy after they have once become generally established in a grove.

4.—"Experiments by the authors, and by citrus growers in cooperation with the authors, involving the treatment of thousands of trees with suitable "checks" or "controls" have shown that when fungus (red or yellow *Aschersonia*) even in small quantities is present in a grove, there is no certainty that from three to six applications of fungus spores in water solution will result in an increased abundance of the infection on the treated blocks of trees by the end of the season. In some of the most important and carefully planned and executed experiments, the fungus has increased more rapidly in sections of the groves which were not sprayed with spore solutions than in the experimental blocks".

The Brown-tail caterpillar is attacked by the fungus *Entomophthora aulicae*, and an attempt was made by Speare and Colley in 1912 to use it in the control of the pest. They state that considerable success has attended their efforts, not that the fungus is a "cure-all" but it is a powerful check. Under proper conditions of introduction from 63 to 100 percent of the caterpillars can be destroyed.

Reference has already been made to the "Wilt disease" of Gypsy-moth caterpillars as a factor in the control of these pests in New England. It made its appearance about 1900 and is now distributed over the territory infested with the Gypsy-moth, according to Glaser. It is an infectious disease but epidemics occur only in localities infested heavily with the Gypsy-moth. Infected caterpillars become flaccid and later their tissues disintegrate completely, due to the fermentative and toxic nature of the virus. The brown liquid of a dead caterpillar shows under the high power of the microscope large numbers of polyhedral bodies of various sizes, but the exact nature of the causal organism has not been determined. The virus is filterable with difficulty.

The success of wilt infection experiments is absolutely dependent upon attention to seemingly insignificant details, but this much is known that infection takes place through the mouth by means of the food.

It is probable that further studies of the disease will evolve some practical method of using the virus for the destruction of larger numbers of the caterpillars. Already, however, it has been ascertained that climatic conditions appear to bear an important relation to wilt in the field, and that temperature has an important relation to the period of incubation of wilt.

The Complexity of the Problem.

The problem of the control of insects by the natural agencies I have just mentioned is in most cases a very complex one, on account of the large number of factors operating, many being for the present beyond man's control. Under one set of conditions a certain control is observed but under another set of con-

ditions where the same factors, it may be, are operating but under relatively different intensities, the result is different.

While progress in the control of insects by natural means may appear very slow, and the results meagre, considering all the efforts that have been made, yet when we look back over the last forty years and scan the records of achievement, whether they be successes oar failures, one fact looms up distinctly, that much advance has been made towards a better understanding of the operation and the inter-relations of the factors. With this valuable knowledge we may confidently press forward to other achievements which will eventually give us the clue to the control of injurious insects by natural means.

REPORT OF THE DELEGATE TO THE ENTOMOLOGICAL SOCIETY OF ONTARIO

By Firmin Letourneau, Oka.

The "Quebec Society for the Protection of Plants" had delegated me and I had the honor to take part in the deliberations of the Fifty-Sixth Annual Meeting of the "Entomological Society" of Ontario, held at Ottawa, Thursday and Friday, November 6th and 7th, 1919.

The assembly was large and most of the Canadian entomologists, as well as several from the United States, formed the deliberative part of it.

The Addresses given were generally short, but of the greatest importance, as usual.

At the first sitting, the President of the Society, Mr. L. Caesar, professor, Ontario Agricultural College, Guelph, and Mr. W. A. Ross, Dominion Entomological Laboratory, Vineland Station, Ontario, spoke of the most pernicious insects of last year: to wit: the Codlin Moth, the Cigar-case bearer, the Blister Mite, the San-Jose-scale, the Pear-slug, the Tussock-Moth, the Plum-weevil and the Potato-leaf-hopper. The particulars given in connection with each of them were most interesting.

Mr. R. C. Treherne made a short report of his work at the Dominion Entomological Laboratory, Vernon, B. C., and Mr. G. C. Spencer, Guelph, a soldier of the Great War, closed the first session by giving the meeting an idea of the experimental work he was conducting with *Chloropicrin* for the control of insects injurious to grain.

Dr. C. G. Hewitt, the great entomologist whose voice is now silent for ever and who is regretted by the whole scientifical world, gave the last address of the second session of the 6th. He spoke of the new insect *Ephydra hians,* which had made its first appearance in the Canadian West.

At this same session, Mr. George A. Moore, Montreal, gave a 15 minutes address on our common Cercopids; Mr. W. A. Ross, gave new particulars on the control of the Pear Psylla; Rev. Fr. Leopold, of La Trappe, made a short but substantial report of his experiences this year in dusting and spraying; Dr. S. Hadwen, Ottawa, noted his recent observations on Eastern Ticks, prejudicial to animals; Mr. Tothill, Fredericton, gave his method of controlling insects by natural agents and Dr. J. M. Swaine, Ottawa, spoke of the Spruce Budworm, the most injurious insect to Spruce and Balsam in Quebec.

Dr. Swaine said that this insect had already destroyed a large part of our Spruce and Balsam forests, specially in the Gatineau, Saint-Maurice and Rimouski regions. Up-to-now, the Gaspesian forests alone have remained free from its ravage. (The 11th report of the Society, page 45).

The night session of this first day of the meeting was presided over by Dr. Grisdale, deputy-minister of Agriculture.

Mr. Marlatt, Chairman of the Federal Horticultural Board of Washington, made such a practical report of the different methods and means used in the United States to prevent the entrance of new insects into America, that I am induced to give here a summary of his remarks:

"A whole host of pests have come into the states during the last twenty years and have become naturalized, and now we have to combat them as best we can. We have lately concluded our list of foreign insects that have come into this country or are likely to come, and the Plant Pathologists are doing the same thing for their line of work. It is the unknown things that are the evils. These things we never suspected in the past until we began to suffer from them, and now, through one cause or another, we loose nearly two billion dollars per year, according to the current prices of our crops. As early as 1907 we got a bill before Congress to control the importation of these pests, the chief of which at that time was the San José Scale, but after hanging fire some years the bill failed to pass. Congress objects strenuously to legislation of this kind as being centralization of legislation. The nursery men also object.

Then came the Brown-tail and the Gypsy Moth from Europe, causing immense damage and we had no legislation to control it. I had a hard fight for four years to get the bill through, with many rebuffs from individual Congressmen: men who were the chief supporters of the bill at last, the very men who finally got the act through. This act gives us power over all plants or plant products coming in from foreign countries and over inter-state movements that may introduce insect pests. Its scope is very broad. The men are appointed from the Bureaus of Plant Industry, Forestry and Entomology and the act is promulgated by the Secretary of Agriculture.

"The Act requires the co-operation of the whole world: India, China, Europe and Canada and over 30 foreign countries have now appointed various experts. The head-quarters of our service is Washington with inspectors at all points of Entry and men in every state......

"Notwithstanding all this, insects come in from Europe so we promulgated the "Plant Quarantine Act 37", the law which caused all the trouble in 1918 lest we exclude every plant from abroad. It has developed on this side the nursery stock industry to a large extent and we do not have to go outside for anything but absolutely necessary stock which we allow to enter so long as it does so through the agency of the Department of Agriculture and its safe-guard. In this way we are becoming independent of other countries and we are not risking the importation of foreign insect pests.

Friday, the 7th, Mr. W. Lochhead, Macdonald College, gave an interesting address to the meeting on "Hopkins' Bioclimatic Law". Mr. Winn, Montreal, whose address was titled "On the Wings of the Wind", delivered a splendid address on butterflies, then came Mr. Norman Criddle, Dominion Entomological Laboratory, Treesbank, Man., with his favorite canvas: "Locusts in Manitoba with special reference to the ourbreak in 1919."

Mr. Brittain, Truro, gave a very interesting address: "Symposium on the Cabbage Root Maggot and its Control in 1919." (Refer to the 9th report of the Society, page 31). The insect (*Phorbia brassicae*) lays its eggs near the stem of the cabbage, on the soil. Worms go down into the soil and attack the roots of the plant which wilts and often dies. Mr. Brittain said that, as a means of control, the tarred paper, placed about the stem, close to the soil gave good results. But, by his own experiments, he contends, and this is affirmed by many of the entomologists present, that to kill the insect it is quite sufficient to sow along the row of cabbages, some clay mixed with creosote. This mixture would not cost more than 5 cents per 100 pounds.

Many other addresses were also given: Mr. F. J. A. Morris: "Life-History of a Hobby-Horse"; Mr. E. H. Strickland, Entomological Branch, Ottawa: "Present Status of Pests of Canadian Flour Mills"; Mr. Hudson, Dominion Entomological Laboratory, Strathroy, Ont.; "Our common June Beetles"; Mr. Downes, Victoria, B. C.; "Control of the Strawberry Root Weevil"; Mr. Ross, Vineland Station, Ont.: "The Strawberry Weevil"; Mr. Arthur Gibson, Ottawa: "Borers in Corn and other Field and Garden Plants which have been or may be mistaken for the European Corn Borer."

REPORT OF THE DELEGATE TO THE CANADIAN BRANCH OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY.

Professor B. T. Dickson.

Mr. President and members:—

I have the honour, as your representative at the annual meeting of the above Society, to present herewith a report of the proceedings.

The meetings were held at Guelph, Ont., in the Biological Building of the Ontario Agricultural College, on Dec. 11 and 12, 1919.

There were present about forty members among whom may be mentioned:— Dr. A. H. R. Buller of Manitoba Univ., Prof. W. P. Fraser of Saskatoon and late of Macdonald College, Dr. W. H. Rankin of St. Catherines, Dr. J. H. Faull of Toronto Univ., P. A. Murphy of Charlottetown, P.E.I., and W. L. Drayton of the Central Experimental Farm, Ottawa.

The guest of the Society was Dr. E. C. Stakman, of Minnesota, a practical authority on Rusts of cereals.

The meeting opened with the Presidential address by Prof. J. E. Howitt of the O. A. C. He dealt concisely in his remarks with the following points:— The immediate and pressing need for some arrangement whereby contributions to our knowledge of Plant Pathology may be published in Canada; the education of Plant Pathologists both as to their technical studies and as to their relations with the agricultural community; the value of standardizing the requirements in the training of Plant Pathologists; the unification of recommendations to farmers; and finally the need for a plant disease survey of the Dominion.

The President's address opened up avenues for discussion of which advantage was taken, especially at the evening session.

This evening meeting took the form of a Smoker and was very much enjoyed by all present. Dr. Stakman dealt with the "Rust Problem". He is a forceful speaker, enthusiastic in his work, and consequently he held his audience spellbound for an hour. It is impossible, unfortunately, to do more than state the salient fact of his address in this report. He showed very clearly that, whilst urediniospores of *Puccinia grammis tritici* may live over winter and then give rise to the commencement of an outbreak of Black Stem Rust of wheat, the barberry was a still potent agent in this respect. He strongly advocated the thorough extermination of the common barberry (Berberis vulgaris L.) and its replacement by the Japanese barberry (Berberis Thunbergii) or some other equally ornamental but harmless shrub. He pointed out that a hybrid between the common barberry and the Japanese barberry was also an alternate host, and that this hybrid looked remarkably like the true Japanese barberry.

Dr. Stakman also spoke on Friday afternoon, Dec. 12th., when he discussed some of his work with Biologic species in the cereal rusts, illustrating his remarks with lantern slides.

Following his evening address came a discussion of the educational requirements of Plant Pathologists. Dr. J. H. Faull opened the discussion. After an animated consideration of the various subjects which came within scope of the work of a practising Plant Pathologist it was decided to appoint a committee to draw up recommendations, the committee comprising: Dr. A. H. R. Ruller, Dr. J. H. Faull and Prof. J. E. Howitt. A report will probably be forthcoming at the next annual meeting. It was also resolved that the above committee be authorized to wait upon the Minister of Agriculture to urge the early appointment of a Dominion Botanist who can command the confidence of Plant Pathologists and Agriculturalists generally.

The papers given during the sessions covered a wide field and it is impossible to give a detailed account, but an attempt will be made to give the substance of each.

"Health and Disease in Plants", by F. L. Drayton.

In this paper it was urged that greater attention be paid to physiological studies and to the normal and abnormal structure of plants in order that an intelligent attempt may be made to understand the nature of diseases in plants. In this all those who have the science of Phytopathology at heart will agree with him for that science cannot be allowed to desiccate in a mycological herbarium.

"Decay in the Timber of Pulp and Paper Mill Roofs", by R. J. Blair.

The moist conditions obtaining in pulp and paper mills permit of the rapid development of wood rotting fungi so that roofs require to be renewed every six or eight years. The chief fungi concerned are:—*Lentodium tigrinum, Lenzites trabeum,* and *Poria xantha.*

The remedy for such timber decay involves the following four points:—use of timber which is resistant to decay; ventilation to remove excess moisture; liberal dry air heating; and the placing of a layer for heat insulation on the upper side of the roof planks.

"Butt Rots of the Balsam Fir in Quebec Province", by W. H. Rankin.

Dr. Rankin explained the dying of Balsam Fir over extensive areas as being due to the Spruce budworm and to Fomes pinicola, the latter giving rise to a butt rot. In most cases he found that the taproot was first infected and that from the taproot the disease spread to the butt.

"Leaf Blight of the Pine", by J. H. Faull.

A deathrate as high as 5% was found in some areas of northern Ontario. The symptoms are very similar to winter browning, and in fact many lumbermen speak of it as frost injury. No inoculation experiments were successful. Young trees in most cases recover.

"Pseudorhiza of Certain Saprophytic and Parasitic Agaricineae", by A. H. R. Buller.

Dr. Buller showed that typical pseudorhizae were not uncommon among the Agaricineae and illustrated his paper with lantern slides from photographs. These were of pseudorhiza carefully excavated and photographed in situ.

"Some comparative observations upon the shape of Basidia and Method of Spore Discharge in the Uredineae and Hymenomycetes", by A. H. R. Buller.

In this very interesting paper it was shown that the shape of the basidium and of the promycelium was always such as to allow of the rapid and unhindered discharge of the spores when mature. Dr. Buller also showed that, contrary to the statements of certain German scientists, there was always formed just prior to spore discharge a minute drop of liquid at the "hilum" of the spore. When the basidiospore was discharged this drop was carried by the spore. The time occupied in the formation of the drop was of such short duration that this fact accounted for the lack of general observation of its formation.

"Witches Broom of the Canada Balsam and the alternate hosts of the causal organism", by R. E. Stone.

Dr. Stone gave a short account of his infection experiments with Aecidium elatinum Alb. et Schw. to show its relation to *Melampsorella cerastii Pers.*. He had been able to produce infections on *Stellaria media* by acciospores from *Abies balsama,* and also on *Cerastium vulgatum* from the same source.

Arthur has connected *Aecidium elatinum* and *Abies lasiocarpa* with *Melampsorella cerastii* on *Cerastium oreophilum.*

Wier connected Aecidium on *Abies lasiocarpa* with *Cerastium oreophilum* and *Stellaria borealis.* The same aecidium is reported on *Abies grandis* but no culture work has been done.

There is an aecidium on the western spruces, *Picea angelmanii* and *Picea paryanna* and on Norway spruce in the west. Aecidium is known as *Aecidium coloradense* and Weir has connected this Aecidium on *Picea engelmanii* with the Melampsorella on *Stellaria borealis* and *Stellaria longifolia,* so that it seems possible that this aecidium on spruce is the same as the aecidium on the balsalms and firs, but more work on this should be done.

"New or little known diseases of the potato which cause the running out of seed", by P. A. Murphy.

Mr. Murphy described pathological conditions of potatoes which were denominated "Streak", "Crinkle", and "Leaf drop", these names clearly indicating the symptoms in each case.

"A Smut of Western Rye Grass", by Professor W. P. Fraser.

A smut of Western Rye Grass is prevalent in the prairie provinces of Canada, sometimes the percentage of infection being as high as 60% or more. This smut attacks the spikelets and sometimes the glumes. The smut is close to *Ustilago bromivora,* but is regarded as distinct by Dr. Clinton and has been named *Ustilago Agropyri Clint.*

Field experiments and laboratory studies have shown that this smut belongs to the seedling infection group. The smut is carried over the winter by spores on the seed. The ordinary seed treatment by a solution of formalin gave complete control, and no injury of the seed was evident.

"Some Observations Made in Inspecting for Leaf Roll and Mosaic", by Prof. J. E. Howitt.

During the past two seasons (1918-1919) an effort has been made to improve the potato crop in Southern Ontario. This involved disease surveys of the potato growing sections of Southern and Northern Ontario; a system of inspection and certification for disease in seed potatoes, and the testing for disease and yields of potato seed grown in Northern Ontario, Southern Ontario and New Brunswick.

The seed from these sources was grown side by side on eighty different plots in forty counties of the Province during the past two years, and records kept of the percentage of serious disease and yield per acre. The results obtained and the observations made during the carrying on of this work may be summarized as follows:—

Seed potatoes grown in Northern Ontario are freer from Leaf Roll and Mosaic and give larger yields per acre than those grown in Southern Ontario and New Brunswick. Leaf Roll is especially prevalent and severe in the Southern and South Western portions of Southern Ontario. In most sections of Southern Ontario, Leaf Roll appears to spread and cause more loss each year that the same seed is used. In Northern Ontario, Leaf Roll does not seem to spread nor to increase appreciably in amount from year to year in the same stock. Under climatic conditions such as we have in Southern Ontario, Mosaic appears to be suppressed some years. That is, when seed from Mosaic stock is planted in some seasons, no Mosaic is observed in the resulting crop. In Northern there appears to be no such suppression of Mosaic, it apparently appears in infected stock year after year. Mosaic evidently spreads in the one year from diseased to healthy plants and one of the chief agents in its transmission appears to be the Leaf Hopper (Empoasca mali Le Baron.)

"A new disease of the poplar", by A. W. McCallum.

A disease, well-known in Europe, caused by *Napicladium Tremulae* (*Frank*) Sacc. is recorded for the first time on this continent. It is characterized by the death of young shoots and the shrivelling of the leaves. Only the conidial stage has been observed as yet, this being common on *Populus tremuloides* and *P. grandidentata* in Ontario and Quebec.

"Some data on peach yellows and little peach in Ontario", by L. Caesar.

The first appearance of yellows in Ontario was about the year 1874 and of little peach about 1895. The outbreak reached its culmination in 1911 when there was a loss of approximately $1,000,000. Experiments to prove transmissibility of the disease gave varying results but orchard inspection and past experience tend to show that the removal of diseased trees is by far the safest plan, especially as a safeguard against an epiphytotic.

At the close of the session Dr. Rankin and Prof. Fraser were named a committee to consider the taking of a plant disease survey of the Dominion.

The following officers were elected for 1920:

President............................Dr. A. H. R. Buller
Vice-President...........................Dr. J. H. Faull
Sec.-Treas..............................Dr. R. E. Stone
Councillor............................Prof. J. E. Howitt
Councillor...............................F. L. Drayton

A BRIEF STUDY OF A FEW CECIDOMYIIDAE

By Dr. J. C. Chapais, St. Denis (en-bas).

Though I am not an entomologist by vocation, it happens, now and then, that I make an excursion in the field of entomology to find out those insects that are either noxious or useful in agriculture so as to establish the amount of their noxiousness or of their usefulness and to learn how to destroy or protect them.

This is the reason why I wish, to-day, to make this brief study concerning a few insects of two or three genera of the nematocerous Diptera (insects with flamentous antennae) or small two-winged flies, typical of the family Cecidomyiidae.

The family comprises a vast number of minute slendered-bodied midges, which are of special interest on account of their mode of life, the peculiar structure exhibited in the larvae and the economic importance attached to several species. In most cases, the female lays her eggs in the stems, leaves or buds of various plants, producing gall-like excrescences of various forms inhabited by the larvae.

The Hessian fly, **Mayetiola destructor** (Say). Healthy wheat stock at left and infested stock at right; a—larva; c—puparium or "flaxseed"; d—pupa exposed; e—adult female laying eggs; f—female; g—male; h—puparia or "flaxseed" in natural position between leaves and stalk; i—parasite (**Merisus destructor**). (Slightly enlarged, excepting e, whis is smallar than natural). (After Riley, Burgess and Forbes)

Some species, however, do not produce galls, and among them are the Hessian fly, *Cecidomyia destructor* or *Mayetiola destructor,* Say (*Cecidomie destructrice*) ; the *Dasyneura leguminicola* Lint, Clover flower-midge, Clover seed-midge (*le moucheron du trèfle*) and the *Dasyneura rhodophaga* Coq, Rose-midge (*Moucheron de la rose*). These last three mentioned insects, and another one which produces galls on the fruit of the Choke-Cherry tree (*Cerasus Virginiana*) and called *Cecidomyia* or *Contarinia Virginiana* will be the subject of the few notes I intend to communicate to you in the present study.

I do not pretend to impart new knowledge concerning the Cecidomyiidae in the following notes. All I mean to do is to extract from a few bulletins, written in English, the substance of what they contain about the four insects above mentioned and to communicate it in the French version of our report to my French

countrymen who have not the advantage of reading it in English, not absolutely because they do not, some of them, know that language, but because they have no occasion to read the English bulletins.

I shall take these cecidomyiids in the order they occupy in my mind, according to the dates of our acquaintance with them. The first, the Hessian fly, I have known for forty years. This insect is so well known in Quebec that I am not going to speak of it at length, nor even describe it as it is found in the two Canadian works which were written about it as early as in 1856. I mean the essays by Hind and Provancher under the pseudonym of Dupont. I purpose here giving a summary of the control measures to be taken against this terrible foe of our wheat crops. These measures, after Criddle, are the following:

(1) Plowing all infested stubble land between August 15th and the middle of May of the following season, plowing to be not less than five inches deep; (2) burn all stubble and straw piles between the dates mentioned above; (3) carefully gather up all screenings and use the same as feed, or destroy them before May 15th; (4) infested land unable to be treated by plowing or burning at the proper time should be disked or cultivated as soon as possible and plowed June 20th; (5) sowing strips of grain about 20 feet wide between infested stubble and newly planted grain to attract flies may be resorted to on occasions of severe outbreak (The strips should be planted early and plowed down about the middle of June); (6) prepare a good seed bed and use the best of seed. Vigorous plants will be more able to resist attack; weak ones are easily killed out.

The second cecidomyiid with which I came into contact was *Cecidomyia Virginiensis* or *Contarinia Virginiana* Felt. In the Summer of 1915, I saw in a Choke-Cherry tree an abnormal agglomeration of ill-shapen fruit in many of the ordinary clusters. Looking attentively at them, I thought that they resembled the plum pockets found sometimes in plum trees subject to the invasion of the *Exoascus*. They were of course smaller, being on an average twice the size of an ordinary Choke-Cherry. Upon examination, I found them filled with a swarm of very small red larvae. After having sent the specimens of these galls and larvae, first to Dr. C. Gordon Hewitt, Dominion Entomologist, Ottawa, I learned that the galls were due to the fact that the Choke-Cherry fruit had been punctured and filled with eggs of the Cecidomyia Virginiensis, and later I received from Dr. E. P. Felt, New York State entomologist, of Albany, the best American authority on Cecidomyiidae, a letter revealing quite a host of insects inhabiting those galls, such as: *Arthrocnodax spiphila*, *Contarinia Virginiensis* (Felt), *Cecidomyia Virginiensis*, *Itonida Canadensis* (Felt), *Parallelodiplosis acernea (Felt)*, *Lestodiplosis*, *Dasyneura leguminicola*. This second Cecidomyiid may not be very noxious, especially if we compare them with the damage caused by the *Cecidomyia destructor*, previously mentioned, and the next one that we are going to submit to our investigations, the Clover-flower midge, *Dasyneura leguminicola*.

This Dasyneura was the third cecidomyiid with which I became acquainted, in 1918, in a clover-seeded orchard of Saint-Remi de Napierville. This is, as in-

dicated by its name "Dasyneura leguminicola", a cecidomyiid causing havoc of all clover crops. I first saw it in Napierville, in July, and it had invaded the whole area of an orchard of 2 x 4 arpents. Not less than three fourths of the crop was destroyed by these tiny, bright-red insects invisible in the well sheltered depths of their leguminous abode.

I know of but one means of fighting this minute enemy of our clover crops; it is that of mowing down the first crop of clover as soon as it is in bloom. The first generation of this foe, which would otherwise invade the second crop, will thus be destroyed and will ensure a clean second growth.

The fourth cecidomyiid is known to me only through engravings, and we consider it is a lucky thing for our Quebec rose growers that we do not know it otherwise yet, for, it is said to be one of the most noxious insects to be met by flower growers. It is called *Dasyneura rhodophaga* or the rose midge (*Le moucheron de la rose*). The first article that I read concerning this rose midge occurs on page 33 of the report of Dr. Hewitt, Dominion Entomologist, for the year 1914-15. It reads as follows:

"Rose Midge (*Dasyneura rhodophaga* Coq).In July, specimens of rose "shoots (variety Mrs. J. Laing, H. P.) were received from London, Ont., the "tips being "destroyed by a Cecidomyiid larva. About three hundred rose-bushes "had been affected in this manner. Specimens were submitted to Dr. E. P. Felt, "who reported that it was probably the Rose Midge (*Dasyneura rhodophaga* "Coq), with which suggestion the observations we made agreed. This appears to "be the first record of this pest, which is considered to be the worst pest with "which the rose grower has to deal. An investigation of the insect is being under- "taken".

The forty-seventh report of the Entomological Society of Ontario for 1916 tells of another outbreak of that insect in Canada in the green house of Messrs Miller & Sons, of Toronto. It gives also the life-history of that insect.

It has been observed for the first time in America in the green house roses of the State of New-Jersey.

"The perfect insect, or midge, is two-winged and is closely related to the "Chrysanthemum Midge. The female deposits its yellowish eggs, which are so "small as to be hardly visible to the naked eye, beneath the sepals of the flower "buds or between the folded leaves of the leaves buds. The egg period is recorded "as being only two days. When the young, whitish maggots hatch they at once "begin to destroy the terminal leaves and the blossom buds, and in from about "five to seven days they become mature and then leave the plant, dropping to the "soil where they change to the pupal state. Webster has observed as many as "twenty five larvae in a single blossom bud. David states that in summer the fly "emerges about six days after pupation occurs. In green houses in Chicago, the "insect has been present from June until October or November in such numbers "as to make is impossible to secure a single crop of flowers. During the colder "winter months, it is assumed that the insect is present in the pupal state in the "green house soil."

This report gives also three good drawings of the egg, larva and puparium of the rose midge and one of a rose bud destroyed by the larvae of the rose midge.

I hope these few notes on four of the Cecidomyiidae that we meet or are liable to meet on our growing economic plants may be of service to some of the members of our Association.

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P.S.—When I copied, a few weeks ago, from the report of Dr. Hewitt for the year 1914-15, the quotation concerning *Dasyneura rhodophaga,* I was far from thinking that when I would present this paper to you the late Dr. Charles Gordon Hewitt would have left us for the hereafter. I am really deeply grieved at his departure. It is very painful to think that such a gifted and learned young man is no more amongst us and that he will live only in our memory which will long recall his quiet behaviour and friendly way of imparting his extensive knowledge of Entomology.—J. C. C.

THE ESSENTIALS OF A DOMINION PLANT DISEASE SURVEY.

F. L. Drayton, Plant Pathologist, C. E. F., Ottawa.

Plant pathological work in Canada is severely handicapped on account of there being no organised survey of the plant diseases occurring in the Dominion. My main object in choosing this subject is to stimulate discussion, in the hope that many points of value in the carrying out of such a project may be brought up, and your wholehearted co-operation enlisted in helping to make a survey of this kind, which is to be put into operation this year, as comprehensive and as useful as possible. Dr. W. H. Rankin, Officer-in-Charge of the Dominion Field Laboratory of Plant Pathology in St. Catherines, has the organisation of this survey under his direction, and you will no doubt shortly receive some information from him on the subject.

In undertaking a project of this kind, the greatest difficulty is going to lie in the comparatively small number of possible co-operators in the Dominion in relation to the large area to be covered. It will necessitate commencing in a small

way and hoping that each year the number of co-operators will be increased, and consequently make the survey more extensive.

Most of the advantages to be derived from a well-organised plant disease survey would be familiar to you, but I am going to rapidly review them, so that later they may suggest to you points for discussion.

1. The rendering of assistance of fundamental importance to plant pathologists in their investigation work by:
   (a) placing at their disposal information demonstrating the problems requiring the greatest attention, and
   (b) supplying such information as prevalence, geographical distribution and severity, and so placing the chosen problem on a broad basis from which to build up lines of research.

2. An annual report by itself has considerable use, but its full value cannot be realised until it has become one of a series, recording year by year the fluctuations in amount and destructivenesse of any disease in accordance with changes of temperature, soil, moisture, etc., so adding to our scant knowledge of environment in relation to disease infestation and the possibility of being able to predict an epidemic through knowledge of the weather conditions found to be most favourable to an outbreak, together with the experience of former years as to the time of year when such an infestation may be expected.

Careful accumulation of data on epidemics would also lead to a better understanding of the conditions influencing the development, spread and control of such outbreaks.

3. It gives everyone the benefit of the experience of others on the resistance or susceptibility of certain varieties.

4. It disseminates results derived from various methods of control.

5. A record of the appearance of new diseases or the possible introduction of others from other countries is of extreme importance.

6. An organised survey would be a means of collecting information about any disease requiring immediate attention.

7. Last, but one of the most important, the education of the public to the importance of plant disease investigation by the published account of losses sustained from various diseases, and thereby assisting the plant pathologist to get recognition of his work.

The record of the presence of a disease is as important as the amount of material damage incurred. Positive figures are always extraordinarily difficult to obtain, but this does not matter so much provided that figures or terms are used which are comparable and always represent a similar standard. That is, "severe" or "20% reduction of yield" in Alberta should be exactly comparable to "severe" or "20% reduction of yield" in New Brunswick. It will take several years to determine which will be the best method of estimating losses and recording data, but this year the survey would have to be planned in such a way as would permit of the results being compared with the same data gathered by the United States

Department of Agriculture, where a plant disease survey has been in operation since July, 1917. Their practice has been to have one collaborator in each State who collects data from all the persons in that State whom he can interest in the work, and this material is forwarded to Washington for compilation. The method they adopt for reporting losses is in percentage of reduction in yield. Forms are supplied for recording this and other information relative to the survey, together with rules to be followed in arriving at the figures to be submitted. It is uncertain, at present, what form the publication of this data will take in Canada, but it is hoped that it will be published annually as a bulletin from the Division of Botany for general distribution.

The extent and the value of the piece of work will be dependent on the amount of co-operation secured. I would ask you all to give this matter your earnest consideration, and to make your criticism constructive rather than destructive, and render every assistance you can to establish this Dominion Plant Disease Survey on a permanent and beneficial basis.

THE ENTOMOLOGICAL RICHES OF QUEBEC

By Canon V. A. Huard, Quebec.

A title like the above doubtless may need some explanation, for it is not necessary that in reading it some innocent entomologist, on account of the simplicity expected to be met with amongst entomologists, imagines that he has only to run around the streets of Quebec, net in hand, to capture insects without number and of the rarest species. These pages are going to deal, not with living insects but rather with dead insects — with insects dead but preserved in certain methodical ways, otherwise known as an "entomological collection". I wish in other words to point out some advantages the entomologist will find at Quebec to help him in his studies. A brief account of the Quebec entomological collections will serve this purpose.

There are in Quebec but few private collections. In fact I do not know of any other than my own. Its principal characteristic is that it is fifty years old, which indicates sufficiently that its owner has for some time ceased to belong to the category of young men. The collection is a very considerable one and includes the product of my hunts in the vicinity of Quebec and also in that of the Saguenay where I resided for twenty-five years. What gives the greatest value to this collection is that it contains a large number of specimens identified by Provancher and among the Lepidoptera by Dr. McDunnough, the distinguished specialist in charge of the collections of the Entomological branch of the Department of Agriculture, Ottawa.

But I wish to speak here particularly about the large collections that one might term public, which are to be seen at Quebec and which are those of the Museum of Public Instruction and of Laval University.

Public Instruction Collection

The entomological treasures of the Museum of Natural History which belongs to the public instruction service of Quebec consist for the most part of the Provancher collections. But it contains also two other notable collections. One is the Saint-Cyr collection which is a general one, but not very extensive. It was formed by the late D. N. Saint-Cyr, who became the first director of the Museum of Public Instruction, and who studied botany much more than entomology. The other collection referred to is the precious Fyles' collection. Before going to reside at Hull, P. Q., the Reverend Dr. Fyles, one of the renowned entomologists of America, wished to leave in Quebec his collection of Lepidoptera, and the Museum of Public Instruction arranged to acquire it. Dr. Fyles worked for forty years in building up this collection, the result of his hunts in various parts of the Province of Quebec. It comprises more than two thousand species of Lepidoptera, some of which are of great rarity. One might say that it contains nearly all the Quebec species. It is all named, and as Dr. Flyes is a specialist, whom we know, it will be a source of authority for exact determination of our butterflies, if the classification were not still in an unstable state which makes it the despair of the amateur. In any event, the Fyles collection is a thing of beauty in its marvellous arrangement and in the perfection of the specimens which is contains, and which number two or three for each species.

A long time ago—that is to say 30 years—the Minister of Agriculture of Quebec obtained possession of his entomological collection, which was also later entrusted it to the care of l'Instruction Publique. One may say that this collection formed the nucleus of what is to-day the important Museum of Public Instruction. This collection, such as it was, still exists in the Museum of the Palais legislatif.

After the death of Provancher in 1892, the Government of the Province of Quebec obtained possession of his entomological collection, which was also placed in the Museum of Public Instruction. It was then that to my care was entrusted the preservation of the principal entomological collections of my regretted master and illustrious friend, collections which in former times I had studied under his direction, and which contained more than one specimen captured by myself.

These two Provancher collections are in a perfect state of preservation. They have a special importance and value from a scientific standpoint, because they contain the greater part of the TYPE specimens on which Provancher founded his hundreds of new species which he named and described in his publications. Notwithstanding the frequent modifications that scientific progress has brought into entomological classification, I have been very careful to make no changes in the arrangement and determination of these collections which, to my mind, should be preserved as a sort of historical monument. Further, and above all, these collections are to some extent like a commentary on the entomological treatises of

Provancher and should remain so. Thanks to the precautions which I have mentioned, it is then always possible to see at a glance about which species he wished to speak on such and such a page of his works, and that in spite of the changes which are being daily produced in entomological nomenclature.

I wish to add that the College of Levis also possesses a collection of insects acquired long ago from Abbé Provancher and which were the duplicates of his collection at that period.

Collection of Laval University.

The entomological collection of Laval University, which contains fifteen thousand named species, is one of the most important in Canada, and even of America. It was commenced about three quarters of a century ago by the late Mgr. T.-E. Hamel, one of the original members of the Royal Society of Canada, and who was for a long time rector of the University. Mgr. Hamel while one of our most zealous scientists was never a specialist in entomology; but that did not prevent him from taking part in the hunts after insects. I have been the witness of this in my younger days at the holiday residence of the Gentlemen of the Seminary of Quebec, at Saint-Joachim (Montmorency); it was even on these occasions that for the first time the existence of a science called entomology was revealed to me and it was there that the first germs of my vocation of entomologist were implanted in my mind.

The collections increased greatly during the years in which the late F.-X. Belanger, on the recommendation of Abbé Provancher, was appointed to act as curator of the Museum. He published at one time, in the "Naturaliste Canadien", some interesting articles on our native silk-worms. M. Bélanger died in 1882; I knew him well and used to see him walking about with his insect net in the neighborhood of Quebec. He was also an expert taxidermist.

The real curator of the University, who has filled this office for forty years is Mr. C.-E. Dionne, the author of "The Birds of the Province of Quebec", and who is not only a noted ornithologist, but also a learned entomologist. Under his direction, the entomological collections of Laval have been remounted and arranged according to modern methods. They have also, be it well understood, received considerable development. Mr. Dionne, who has much taste and skill, is also a taxidermist of wide reputation.

At one time the Laval entomological collections were united as a world-wide collection. In other words, the Canadian species were placed amongst those of foreign countries thus forming only a unique collection. This is a system which has its advantages from the view point of the general entomologist; but it has also many drawbacks, and it is far from being favourable to study. For the number of species known to-day in entomology is enormous, so that there are no longer "universal" entomologists. It is now necessary to specialize in the study of species of the single country where they live, and the longest life barely suffices.

in our days, to become thoroughly acquainted with the insects of the region where we pass our existence. Therefore Mr. Dionne has very wisely arranged the Canadian collections separately from the general collection.

Conforming with the method now followed, the entomological collection of Laval is preserved in boxes of small dimensions, hermetically closed, which are kept, after being classified, in fine glazed cases; and this arrangement permits one to find immediately the order and the family which one wishes to study.

The collections of Coleoptera, Lepidoptera and Hemiptera are the most important in the Laval museum.

Beside these collections intended for study, there are also in the museum, to gratify the curiosity of visitors, permanent exhibitions of speciments of the principal families of insects, and also groups of the various phases of the life and work of insects, which we know to-day under the name of "life-histories".

Although the museums of Quebec are not numerous and have not as yet the vast proportions and the riches of the large cities of the U.S.A. and of Europe, the Quebec entomologist can state with much pride and satisfaction that his favourite science is receiving special attention there. One may even say that it is entomology that is best represented in the museums of the Provincial capital. Further, the fact that the provincial entomologist has his laboratory in Quebec, and that other fact that Provancher worked all his life in the region of Quebec, as well as all his collections being preserved there; all these have contributed to give to the capital of the Province the distinction of being an entomological centre, whereof there should be a record kept in the history of the science.

THE EUROPEAN CORN BORER.

Prof. W. Lochhead, Macdonald College.

In the summer of 1917 the European Cor Borer was reported as doing damage to corn and other vegetable crops in a limited area in the vicinity of Boston, but during 1918 the infested area was found to extend over 400 square miles, and in August 1919 over 1100 square miles. Besides, the pest was discovered in Jan. 1919 about Schenectady, New York, where the area infested covered about 400 square miles, in August 1919.

In view of the alarming spread and menace of an insect that causes much damage in Europe a conference of the National Association of Commissioners of Agriculture with State Entomologists and Representatives of the U. S. Department of Agriculture was held at Albany and Boston, August 28-29, to look over the infested areas and to give careful consideration to all new points, both practical and scientific, relating to the extermination and control of the European

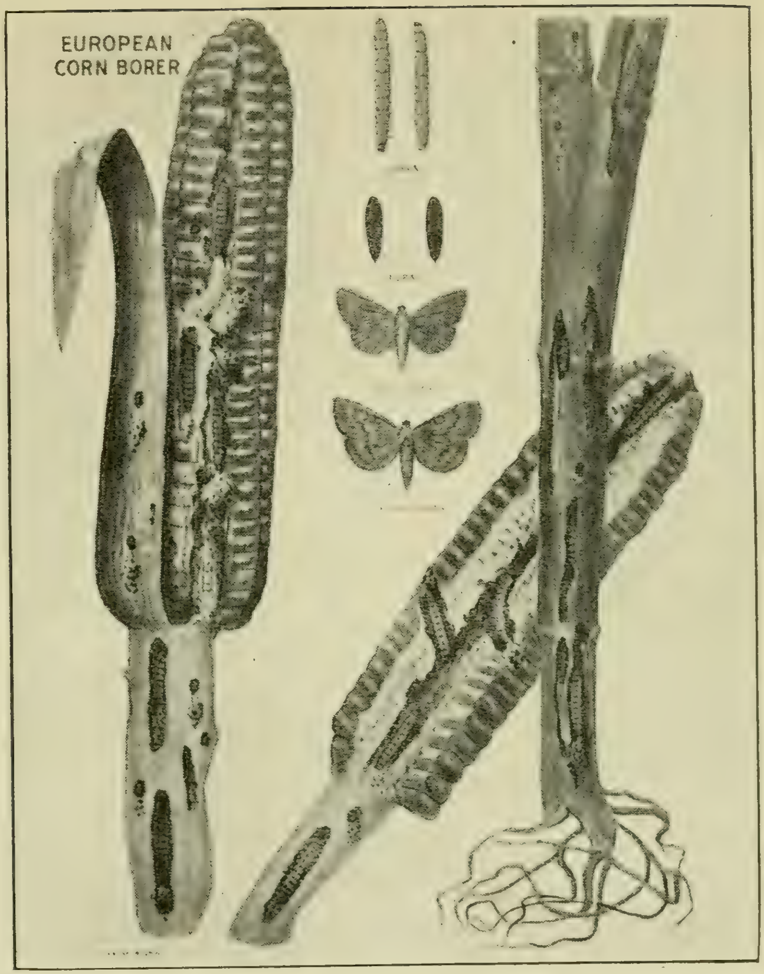


Fig. 1—The life-history of the European Corn Borer, from a colored poster published by the Mass. Com. Ag.

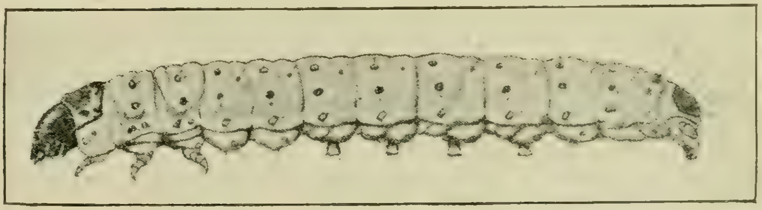
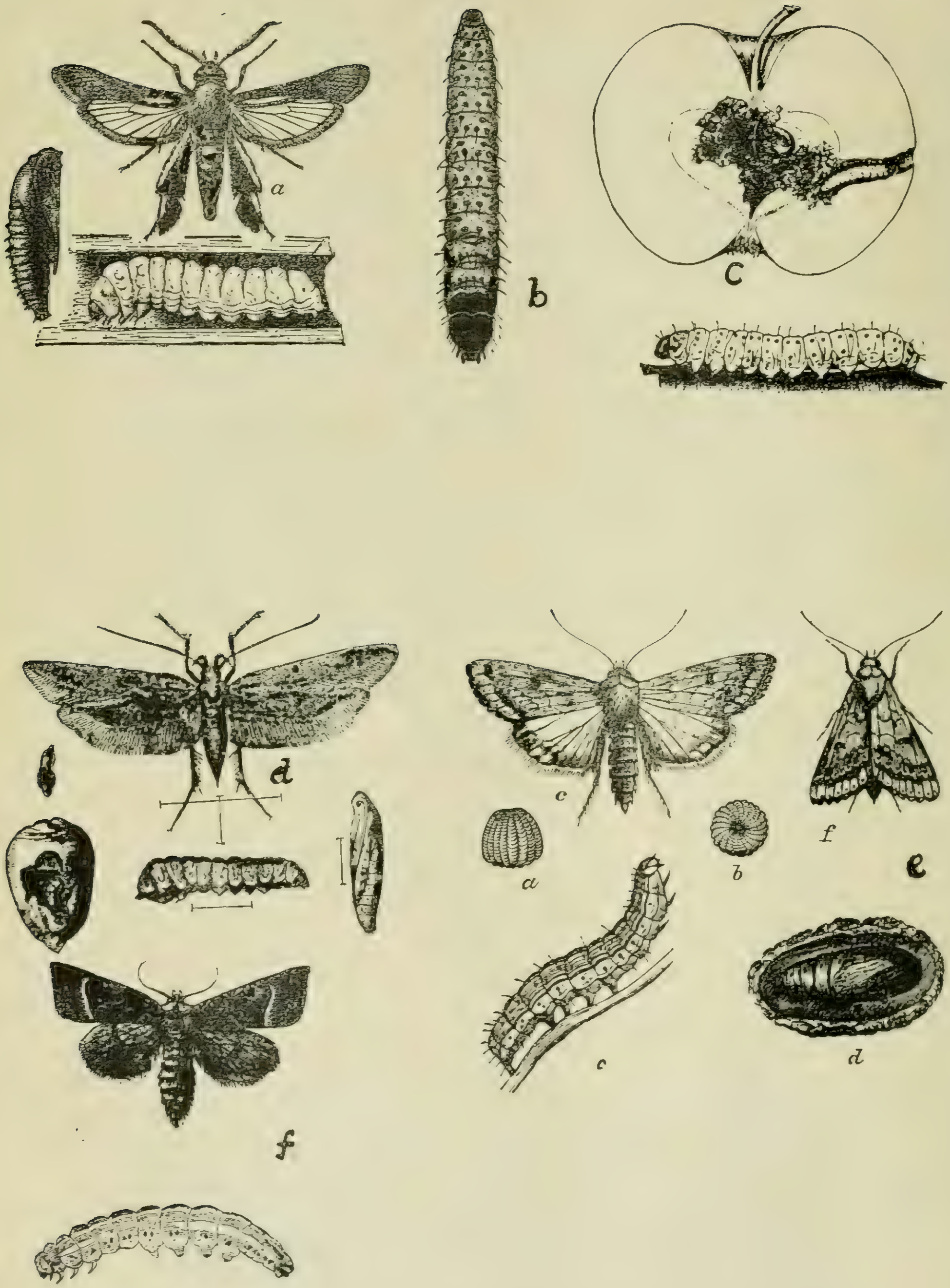


Fig. 2—Full grown larva of the European Corn Borer (much enlarged).



Lepidopterons borers.—a—Squash-vine borer; b—Parsnip web-worm; c—Codling worm; d—Angoumois grain moth; e—Corn-earn worm; f—Common stalk-borer.

Corn Borer. In response to the call a large number of State and Federal agricultural officials and state and federal entomologists attended the conference. Canada was represented by Dr. C. G. Hewitt and L. S. McLaine of the Entomological Branch, Ottawa, and the writer.

The Menace of the European Corn Borer.— At the first conference at Albany, presided over by Hon. Chas. E. Wilson, Commissioner of Agriculture, Albany, Dr. Howard, U. S. Entomologist, discussed the Status of the Corn Borer as a Pest, and Hon. Chas. Adkins of Illinois pointed out the damage that would be done to the corn industry of the U. S. if the corn borer were not controlled; the losses would be enormous on account of the great value of the corn crop.

The European Corn Borer.—a—the parent moth; b—eggs in flat masses on under surface of leaf; c—broken tassel with extrusion of saw-dust-like material; d—infested ears; e—infested stalk with extruded saw-dust-like material; f—borer in a stalk; g—the hibernating borer in stubble and stalks; h—pupa in stalk. (After Snodgrass).

At present the infested areas are quarantined so that no corn can be removed from the areas. Inasmuch, however, as the insect feeds upon and breeds in barnyard grass, ragweed, pigweed and many other vegetables, weeds and grasses, the problem of extermination becomes a very difficult one, and as there are many ways by which the insect can spread—by flight, in ears of corn, in garden vegetables, etc., the possibility of spread to other states is quite readily admitted. Even Canada is not exempt from invasion, and steps will probably be taken to "scout" the border counties.

The Life History of the European Corn Borer.— At the first conference in Albany, Dr. E. P. Felt, N. Y. State Entomologist, gave an interesting account of the life history of the insect and a summary of the recent work about Schenectady in relation to the extermination of the pest, while at the second conference at the State House, Boston, Commissioner W. Wheeler of Mass. and Prof. D. J. Caffey, scientific assistant in charge of the Investigations, discussed the facts that had been revealed in the two years' work with the European Corn Borer in Massachusetts, and the plans for eradication.

The insect winters over as a nearly full-grown caterpillar in corn stalks and some of the large weeds. About the middle of May it pupates and emerges as a moth which lays a large number of eggs in shingled batches on the underside of leaves. The caterpillars from these eggs feed upon early corn and weeds. About the last of July these caterpillars pupate, and early in August another generation of moths appears. These lay their eggs principally on corn and the caterpillars do a large amount of damage, feeding on the stalks and ears of corn. These caterpillars or borers pass the winter in corn-stalks and large garden weeds.

The full grown caterpillar or borer is about an inch long. The head is black and the upper surface of the body brown. Each division bears a row of small dark-brown spots, while several pink lines run lengthwise of the body. (Fig.)

The pupa is cone-shaped, brown and about half an inch long.

The moth is pale yellow, expanding a little over an inch; the female is more robust than the male, and has the markings on the wings slightly different.

As the females of the first brood of moths lay on an average about 350 eggs each, and those of the second brood about 550, it is quite possible for an overwintering caterpillar in an old corn stalk or weed to be responsible for 100,000 borers up to the first of September.

Method of attacks by the European Corn Borer.— The members of the Conference had an opportunity of studying at close range the work of the pest, both in the Scotia district about Schenectady N. Y., and in the District to the north of Boston in the towns of Arlington, Medford, Melrose, Saugus and Malden, where much damage had been done to sweet and dwarf varieties of corn. Autos were provided so that many of the infested fields were inspected.

The Corn Borer tunnels through all parts of the corn plant except the fibrous roots. It causes most serious damage, however, by its work in the stalks and ears, which it partially or totally destroys. Generally it enters the stalk near the base of the tassel and at first tunnels upward. This damage so weakens the tassel that it breaks over before it matures. These broken tassels, with extensions of sawdust-like material at the breaks, are the most conspicuous signs of infestation in a field.

Tunnels are also made downward in the stalk, and when several borers are present, as is frequently the case, the stalk is reduced to a mere shell. The ears of corn are also attacked, and the inspectors have found as many as 15 fullgrown borers feeding upon and within a single ear.

Some idea of the extent of injury to corn plants may be gained from the following statement by Professor Caffrey: "Seventy-five plants, comprising 17 hills, were selected at random from a badly infested corn field at West Medford, Mass., and all the borers found therein were carefully removed and counted. Forty-six borers ,on an overage, were found in each plant, and one of the plants contained 177 borers".

In addition to corn, the stalks of celery, beets, turnips, potatoes, Swiss Chard, beans, spinach, chrysanthemums, gladiolus, geraniums and oats are entered and damaged by the borers.

The Control of the European Corn Borer.— From the foregoing evidence two facts stand out prominently, viz.—*the destructiveness of the European Corn Borer, and the difficulty of finding adequate means of control.* The States of Massachusetts and New York, with the assistance of the federal government, have carried on a vigorous warfare, and in addition to the destruction of infested plants they have quarantined the infested areas.

As the borer passes the winter in corn-stalks and weeds, very effective destructive measures have been carried out *by pulling up and burning all corn stalks together with all old vines and all large weeds throughout and around the gardens during fall, winter and early spring.*

In the district about Boston, however, where the population is dense and the gardens numerous, such measures of destruction present enormous difficulties. New devices for fighting the borer have been tried by the experts in charge of the control work. Two new machines in action were exhibited to the members of the Conference.

One of them was a liquid fire machine, which aroused great interest. There is a powerful pump on wheels to supply the power and a low spraying machine, also on wheels, to distribute the crude oil, which is ejected through 16 nozzles.

The oil is set on fire at the start and as it is dragged over the ground a great sheet of flame covers the surface, emtitting a loud roar and shooting a tremendously hot blaze into the air. This machine is dragged through tall weeds, and while it does not actually consume all of the green vegetation, it destroys every trace of insect life.

It is believed that this machine will be very successful in cleaning up infested tracts of land, especially in the Fall and Spring. The other machine demonstrated works like a mangle. Suspected plants are cut or pulled up, then thrown into the machine where they are crushed between the rollers.

Is the Corn Borer a Menace to Canada ?—The question naturally rises : Will the European Corn Borer reach Canada and become a destructive enemy of corn, seeing that it will be single-brooded? With the history of the pest in Europe, New England and New York to guide us we believe we are warranted in stating that if precautions be not taken in time it will reach Canada in a few years and cause considerable loss. We should, therefore, do everything that lies in our power to exclude it. In spite of the quarantine restrictions in Massachusetts and

New York live specimens of the insect may find their way to Canada through the agencies of winds and commercial importations. The best policy for us to pursue is to make known as widely as possible by posters the appearance and habits of the borer and to "scout" the counties bordering on New England and New York so that all incipient outbreaks may be "nipped in the bud". (Fig).

The Recommendations of the Conference.

At the conclusion of the two-day conference in which the European Corn Borer was studied from all possible viewpoints, the special Committee appointed to suggest a policy of action in relation to the pest submitted the following report which was adopted unanimously by the Conference.

Boston, August 29, 1919.

WHEREAS the European Corn Borer has become well established in both Massachusetts and New York State, and, during the past two years, has seriously damaged both sweet and field corn in Eastern Massachusetts; and

WHEREAS it has spread rapidly this season and will unless speedily checked in both states, spread quickly over large areas heretofore un-infested and in a few years may cause enormous losses which might run into millions of dollars.

WHEREAS, we, the National Association of Commissioners of Agriculture, with official entomologists from many states and representatives of the United States Department of Agriculture, together with representatives of the Canadian Government, present as experts in conference upon the situation, express ourselves, after examining the infested area, as thoroughly convinced that this pest is one of the most dangerous insects which has become established in America, and we hereby place ourselves on record in favor of most energetic efforts on the part of Federal and State agencies to control, and, if possible, exterminate this insect, including in the program vigorous quarantines to prevent its distribution.

The danger of spread is so great, the probabilities of successful control under American conditions so unpromising, that we unhesitatingly recommend most energetic measures to control this very serious enemy of our principal grain crop. The immensity of the interests threatened leads us to advise a comprehensive plan of action which may involve the expenditure by the general government of much larger sums than are recommended in these resolutions.

We urge the present Congress to appropriate and make available for use as rapidly as an effective organization to carry on the work can be secured and developed, in addition to funds already available, two million dollars, the sum to be requested for the calendar year of 1920 to be determined by the future development of the work.

We would at this time call attention to the necessity of all Commissioners of Agriculture and Entomologists throughout the United States of America and Canada taking an active interest in this insect, and we would hereby urge the dissemination of information respecting the situation by the appropriate agencies in each state and by the Federal Government.

We would recommend for the purpose of promoting the control and extermination of this borer the appointment of a committee representing the Commissioners of Agriculture, official Entomologists and the Plant Pest Committee for the purpose of unifying and directing all efforts for securing of appropriations and to aid in the determination of a comprehensive policy.

COMMITTEE

C. P. Norgord, Madison, Wis.
Chas. McCaffree, South Dakota.
Wilfrid Wheeler, 136 State House, Boston.
E. P. Felt, State Museum, Albany, N. Y.
Geo. A. Dean, Manhattan, Kansas.
R. W. Harned, Agricultural College, Miss.

Later Conferences.— Since the Albany-Boston Conference in August, 1919, several meetings of entomologists and Federal and State officers have been held for further consideration of the Corn Borer problem. One of the most important discussions took place at the 32nd Annual Meeting of the Association of Economic Entomologists at St. Louis, where the results and doings of the year 1919 were reviewed very thoroughly, especially by Dr. Felt, Entomologist for New York State, and Dr. Marlatt, Assistant Chief of the U. S. Bureau of Entomology and Chief of the Federal Horticultural Board. Two important points were brought out:—viz. 1. that the Corn-Borer was double-brooded in Massachusetts and single-brooded in New York State; 2. that the area of infestation in December 1919 was 1900 square miles in Massachusetts, 20 square miles in New Hampshire, 500 square miles in the Schenectady district and 400 square miles in Western New York; and 3. that the only kinds of corn that have been shown to be damaged to any appreciable extent are sweet corn and the dwarf flint varieties.

Regarding the habits of the Corn Borer, investigations in Massachusetts in 1919 show that individual females may make a single flight of 287 yards, and that marked individuals were recovered at a distance of 600 yards. Moreover, females may live 33 days, and deposit eggs in small masses during a considerable part of this period—the maximum egg production of one individual being 1192.

Although the insect breeds in about one hundred kinds of plants — weeds, garden and cereal plants, it multiplies freely upon relatively few plants.

It seems that the Corn Borer was introduced into the United States in the years 1909 and 1910, for in those years nearly 10,000 tons of broom corn were imported, chiefly from Austria-Hungary. Of this importation 500 or 600 tons went to a factory in Boston, and a like amount to Schenectady, N. Y., but approximately eight-tenths went to New Orleans, St. Louis, Chicago and other points in the Mississippi Valley and were distributed from these centres to many broom factories. There is, therefore, a great likelihood that the insect has been distributed in this great corn-growing area. For various reasons, practically no effort has been made thus far to "scout" the Mississippi Valley for the Corn Borer.

consequently the corn-growers of those Middle States are naturally impatient at the apparent slowness in determining whether or not the Corn Borer has obtained a foothold.

At the St. Louis meeting differences of opinion were expressed as to the amount of damage the Corn Borer was capable of doing. It would seem that the common coarse field corn is not attacked; if this should turn out to be the case, the possibility of damage in the great corn states is small. Moreover, single-broodedness for the northern areas of corn culture, the possibility of cultural control by the elimination of weeds, and the possibility of effective egg parasitism by *Trichogramma minutum* which destroyed some 43 per cent. of the egg masses of the second brood in Massachusetts in 1919, are all hopeful factors in the situation.

On the other hand, it was pointed out by several entomologists that inasmuch as the importance of the Corn Borer has not yet been definitely determined, and there is a possibility of its being a very serious pest, the authorities should do everything in their power *now* to control it and to prevent its distribution. The action of the federal bureau, however, in asking Congress for half a million dollars instead of two millions recommended at the Albany-Boston Conference was criticized.

Dr. Marlatt, in defending the attitude of the Bureau, said that the program and policy of the Department of Agriculture is: "to make as promptly as possible a thoroughgoing investigation to determine the actual necessities of the case and the possibilities of control. The first consideration under this plan is the determination of the distribution of the insect; the second, to demonstrate on a large scale what may be done to control it; and the third, to co-operate with the several states in quarantine and other measures to prevent spread." He considered that under the circumstances it was unwise to ask Congress for more than half a million.

Insects liable to be mistaken for the European Corn Borer.

As many lepidopterous borers of minor importance occur in the stems of plants they are liable to be mistaken for the European Corn Borer. It is, therefore, important to be able to distinguish the former from the latter.

The more common lepidopterous borers may be grouped as follows (after Mosher, *Journ. Econ. Ent.*, June, 1919):

Aegeriidae—Melittia satyriniformis—Squashvine borer.

Tortricidae—Many Eucosmids—Codling Moth.

Gelechiidae—Phthorimaea operculella—Potato tuber moth; Metzneria lapella—burdock borer; Sitotroga cerealella—angoumois grain moth.

Oecophoridae—Depressaria heracliana—Parsnip webworm.

Phycitidae—Elasmopalpus lignosellus—Lesser cornstalk borer.

Crambidae—Diatraea zeacolella—Larger conrstalk borer.

Pyraustidae—Pyrausta nubilalis—European Corn Borer; Pyrausta penitalis —Polygonum borer.

Noctuidae—papaipema nitela—Common stalk borer; Papaipema cataphracta; Heliothis obsoleta—corn ear worm; Achatodes zeae—spindle worm. (See Illustration)

Besides the more obvious differences of size, color, etc. the caterpillars of these moths may be distinguished, as Miss Mosher has done, by the arrangement of the ocelli, the setae, the clear areas, and the hooks of the prolegs.

SPRAYING TO INCREASE POTATO PRODUCTION

Prof. Georges Maheux, Provincial entomologist, Quebec.

It has been thought heretofore that the only means of raising more abundant potato crops were confined to the *fertilization of the soil* and to the *choice of cultural methods*. Numerous progressive farmers are however realizing that it is not quite so simple, and that in order to succeed with such an important crop, special attention must be paid to the *selection of the seed* and to the *proper protection of the growing plants*.

It would be difficult to determine which of these factors has the greater bearing upon the yield. Both have an unquestionable influence; but it is also known, from the results of numerous experiments, that the selection of seed and the protection of plants by sprayings will insure success. In our opinion, protection means production; protecting according to established rules is practically carrying on a permanent greater production campaign, besides being the assurance of having fine products and big returns.

Besides, the question of the protection of crops has assumed considerable importance in the Province of Quebec during the last few years. For a long time it had been thought that man could devise no efficient means to control parasites. Moreover, if the havocs worked by the Colorado potato beetle were obvious to all, it had struck the mind of practically none that fungoid diseases, which surrepticiously creep into the fields and often ruin the crops, could leave the farmer any other alternative but that of groaning over an endangered or destroyed crop.

In order to overcome these beliefs and this ignorance, prejudicial to agricultural welfare, we have thought it advisable to undertake an educational campaign. Our idea was to enlighten the minds of the farmers and slowly to bring them to realize the importance of protecting their crops in an efficient manner. We particularly tried to get them to understand to what extent pests and epidemics of fungous diseases could bring to nought the most laudable efforts and diminish the yield.

But then, we had to give striking and indisputable examples of what we were setting forth. At the start, a series of occasional demonstrations was given. If a general campaign had been undertaken covering all threatened plants it would certainly have resulted in a failure. It was thought the object could be attained better by selecting one particular crop.

One of the most common crops to-day in our Province and one of the most remunerative is surely that of potatoes. Official statistics clearly show that for three years, the acreage, the yield and the value of this crop have not ceased increasing:

Year	Acreage	Yield	Average Yield	return Average	Total value
1917	226,917	18,158,000	80.02	$1.38	$25,058,000
1918	264,871	38,936,000	147.00	0.98	38,157,000
1919	315,590	57,280,000	181.50	0.85	48,688,000

These figures are eloquent proof of the importance this crop has assumed in our Province as well as of the continuous increase of the average yield per acre. It may be stated, without any fear of error, that this increase corresponds to the ever-generalizing use of protection methods. If only one third of this increase since 1917 be put to the credit of sprayings the net returns realized from this source would reach, this year, $8,000,000 or one-sixth of the total.

On the other hand, taken as total value, the potato crop compares favorably with other crops in the agricultural statistics. It comes third, next to *hay and clover valued at* $32,462,000 in 1919, and *oats valued at* $60,712,000. It might be remarked that the average price of potatoes, figured at $0.85, is rather low. At the price they sold this winter, often as high as $3.00 per bushel, the average price would easily reach $1.00 and the total value would be estimated at $58,000,000.

Unfortunately, this crop which has become so remunerative, has many enemies. Already weakened by the injuries of insects it nevertheless pays a heavy debt to diseases, late blight particularly. These were sufficient reasons to induce us to make the protection of plants more popular.

The ground had been well prepared by the occasional demonstrations started in 1917 and subsequently given by agricultural instructors. They, however, proved inadequate in view of the increasing needs. I previously had the occasion to show what influence they had upon the minds of several farmers; but in order to have the methods of control enter into the farm management, demonstration or experimental fields were organised in 1919 with the assistance and under the supervision of district representatives.

In 40 counties, 60 fields were established. According to our programme, each field had an area of one acre, divided in two even plots of half an acre each; a check plot being provided close by. Each plot was to be sprayed at least four times. The first plot was treated with poisoned Bordeaux mixture, the second was sprayed with lead arsenate. The necessary insecticides and fungicides as well as a Gould knapsack sprayer were supplied by us.

In spite of the difficulties inherent to a new organisation, the sprayings were given regularly almost everywhere. However, uncontrollable delays were occasioned by the fact that there was only one sprayer available for two or three fields.

Results have however gone far beyond our expectations. The fields presented a fine appearance everywhere, insects were kept under perfect control and very few injuries by diseases were noticed. The disease which was most conspicuous was late blight although a few cases of mosaic were also reported.

The gratifying results achieved by this undertaking may be emphasized from three different view points: the yield, the purchase of sprayers and the increase in the number of those fields for the current year.

Yield.—Harvest time was earnestly looked for. Nowhere have we had any disappointment. Plot A (treated with poisoned Bordeaux mixture) gave an average yield 50% higher than that of the check; plot B (on which insecticides only were applied) gave an average of 35% over the check. The following are a few figures taken from reports received by us:

Place	Number of sprays	Yield Plot A	Yield Plot B	Yield per acre A	Yield per acre B	Yield per acre C	Increase A	Increase B
Plessisville . . .	4	132	110	264	220	170	50	30
Saint-Prime . .	5	120	105	240	210	125	96	68
Katevale	5	106	98	204	196	160	28	23
		Average...........		244	209	160	58	40

The grading of the crop took place in the first part of November at several places. The following result was obtained at Katavale:

Healthy tubers, plot A — Healthy tubers, plot B — Healthy tubers, check
100% 70% 50%

The additional revenue contributed by spraying in those 60 fields amounts to $3060 for Bordeaux mixture and to $1,800 for lead arsenate. The average cost of spraying in each field was estimated at about $15.00 (labor included), leaving a net profit of $30. per acre over the check plot.

Purchase of sprayers.— In view of such conclusive results several farmers have made up their mind to get sprayers; in some place 20 persons have already done so. I believe this is one of the best proofs that this experiment has been fruitful. It moreover goes to show that the principle of protection of crops is about to take root in this province; and once adopted on a farm it will last forever.

New fields.—We had intended extending our operations this year. District representatives have received so many requests that 500 of these fields would be required to meet all demands. We have thought that it would be rather difficult for a district representative to properly control more than 4 or 5 of these fields; this will make a total of nearly 200, which will be enough for those who are called upon to supply the necessary material.

This year the work will be completed by the formalin treatment; if, by this means potato crops cannot be increased, we, at least, hope to show that they will be of a better keeping quality; thus ensuring the highest quality of the next crop. crop.

This treatment with formalin will equally apply to oats. About one tenth of the oat crops are lost every year through injuries by smut; which means that $5,000,000 or $6,000,000 are thus lost.

We particularly intend to retrieve such a considerable amount and hope to be successful at least to a certain extent.

Many among you will probably think that it must be rather tedious always to preach the same thing, and to be constantly bent on such elementary work.

In view of the results obtained, which clearly denote the advantages to be derived by the farming community, several will recall to themselves, as I personnally do, that this should be our object and that nothing could be more gratifying to us.

SOME PLANT DISEASES IN THE GREENHOUSE

Professor B. T. Dickson, Macdonald College.

During the past Autumn and Winter 1919-1920 several plant diseases have been prominent in the greenhouse at Macdonald College, Quebec, and a brief account of these may serve a useful purpose. The host plants concerned will be dealt with in alphabetical order.

Carnation (*Dianthus caryophyllus L.*)

Rust caused by *Uromyces caryophyllinus* (*Schrank*) *Wint.* was present throughout the crop but affected principally the slips.

The fungus is propagated principally by urediniospores which are more or less ellipsoidal, 24 to 35 by 21 to 26 microns, slightly echinulate and light brown in color.

Potassium sulphide 1 in 1000 is a useful control.

Cineraria (*Senecio cruentus L.*)

There was an especially fine show of Cinerarias, the plants in most cases reaching a height of 3 feet and having a spread of bloom from 1½ to 2 feet in diameter. Among the plants were representatives of three types:—the ordinary horticultural type with ray florets about 2 cm. long by .8 cm. broad (Plate III), a stellata type having smaller flowers with ray florets 1.3 cm. long by .35 cm. broad, and a cactus type, apparently newer, in which the ray florets did not unfold but remained with the edges rolled back as is well shown in Plate III.

Several noticeable features distinguished this last variety from the other two, long before flowering occurred. The plants were small, not growing more than I foot in height and in many cases not more than eight inches. Their leaves were smaller and since the plant was shorter, tended to a leaf mosaic arrangement. This gave rise to considerable variation in petiolar length. When flowers did develop the flower mass was spindly and more open than in the case of other plants, (Compare Plates IV and V) and considerably less in size.

PLATE III

"Cactus" type of Cineraria flower. (Original)

Ordinary Cineraria flower. (Original)

Healthy "stellata", type of Cineraria. To show normal size of plant and flower clusters. (Original).

The chief characteristic however was the development of a "mosaic-disease" appearance in the leaves. Certain areas in the leaves developed more rapidly than the remaining parts, resulting in blister-like distortions. These areas, plainly seen in Plate VII were of a much darker green color than the surrounding areas. They did not appear in any definite locations in the lamina, being sometimes more numerous nearer the petiole, sometimes nearer the leaf margin and at others scattered irregularly. In all cases, however, they were limited fairly clearly by the veins.

As the plants neared flowering time all the younger leaves showed these strikingly darker areas. No insect pests were present in the greenhouse and no punctures could be observed which might account for the appearance of such distortions. Preliminary tests showed that there was a tendency for the darker portions to retain starch.

Enzyme tests are in progress as also are infection trials. So far none of the latter give satisfactory results since in the apparently successful cases there is still the possibility that he pants were already affected. An interesting fact was noticed with regard to the trichomes. In several cases the trichomes in the lower surface of darker areas had a considerably higher anthocyanin content than normal. No cases of leaves showing these areas occurred in the other two varieties of plants.

All received the same treatment in every respect. It may be that the "cactus" variety is really a diseased variety.

Snapdragon (*Antirrhinum majus L.*)

Snapdragon rust caused by *Puccinia antirrhini (D. and H.)* was very abundant, hardly a plant escaping infection. Seedling, cuttings and mature plants were attacked in all stages of growth. The disease was propagated by urediniospores and but few teliospores were found. The uredinia occurred on the lower surface of the leaves as a rule but there were several cases of such severe infection that pustules appeared on the upper surface also.

The mycelium is localized giving rise to more or less circular diseased areas on the leaves (see Plate VI) and to longer elliptical areas on the stems. The urediniospores are from 22 to 30 by 21 to 25 microns, yellow to brown in color, echinulate to warty and possessing usually two germ spores. They germinate readily in water in a few hours. Frequently they have been germinated in an hour. The plants are rendered unsightly for market purposes by the presence of the uredinia and when infection is severe the leaves are rapidly killed (Plate VI, Fig. 2), resulting eventually in the death of the plant.

It is recommended that clean seed be used as no fungicidal control is yet known, so that it is difficult to obtain clean plants by propagating from cuttings.

Sweet Pea (*Lathyrus odoratus L.*)

The greenhouse grown sweet peas suffered severely this season from powdery mildew of which the causal organism is *Microsphaera alni (Wal.) Salm.*.

The lower leaves were first affected and the mildew gradually spread upwards. Affected leaves were covered with a dense white mycelium and conidia were abstricted profusely.

Tomato (*Lycopersicum esculentum Mill*).

The chief tomato disease was "mosaic" indicating in all probability that the variety propagated was running out. This view was supported by the reduced yield as compared with previous crops.

Leaf Mold caused by *Cladosporium fulvum Cke.* was also prevalent especially towards the latter end of the season.

Violet (*Voila odorata*).

Leaf spot caused by *Alternaria violae G. and D.* was very destructive, the leaves being in most cases killed. The spread of the disease was checked by the use of Bordeaux but spraying the plants with Bordeaux spoils the foliage for commercial purposes. Careful attention at watering time is essential in the greenhause.

ECONOMY IN SPRAYING

Rev. Father Leopold, Oka Agric. Institute.

Spraying is one of the most important practices in fruit-growing; in fact, I believe that it is the most important. You may not care to go to the trouble of cultivating the soil of the orchard, to put in a cover crop, even to prune, but if you wish to market first class fruit, you must spray.

With every item in orchard practice to-day costing much more than a few years ago, it is up to the fruit-grower to practise the strictest economy in all his operations, but especially is this so of spraying with ECONOMY IN SPRAYING.

Economy.—What I mean by economy, you readily understand, is not to spare anything when the time of spraying has arrived or not to put on each tree the quantity and the quality of either dust or liquid applications.

1.—*Economy procured by thorough pruning.* It is evident that in an orchard which is not regularly pruned and well pruned there is a great loss of time and material in applying unduly liquid or dust sprays to parts of trees which should have been eliminated prior to the spraying of each tree. But that is not the main point.

Both insects and fungi harbor on the litter and rubbish distributed on parts of the tree which should have been previously removed by thorough pruning. Preventing the spores of diseases from germinating and the eggs of insects from hatching are so much done in the prevention of pests that may require considerable spraying to overcome. We overlook this point too frequently

Insects and fungi harbor also on the litter and rubbish distributed on the ground and particularly in the accumulation of growth and litter along fence rows

PLATE V

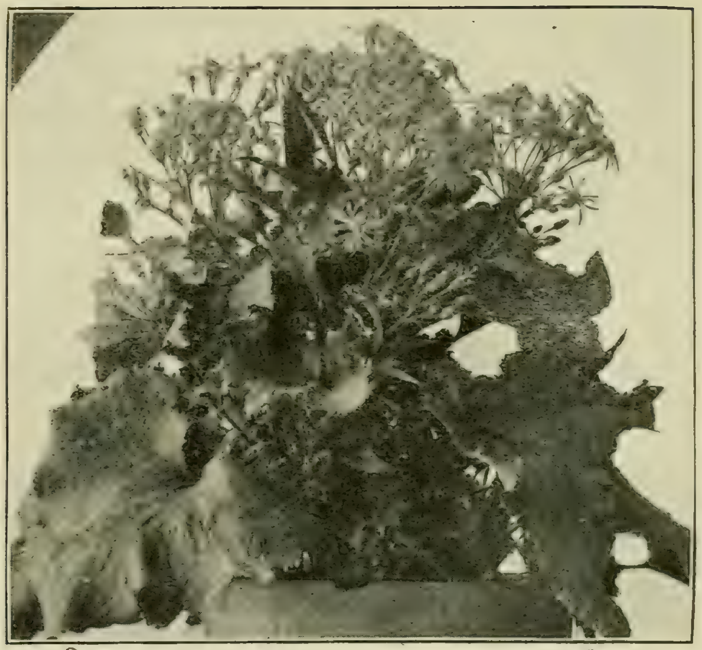


Fig. 1—To show dwarfed growth of plant having leaves affected as in Fig. 2. Note spindling flower clusters. (Original).

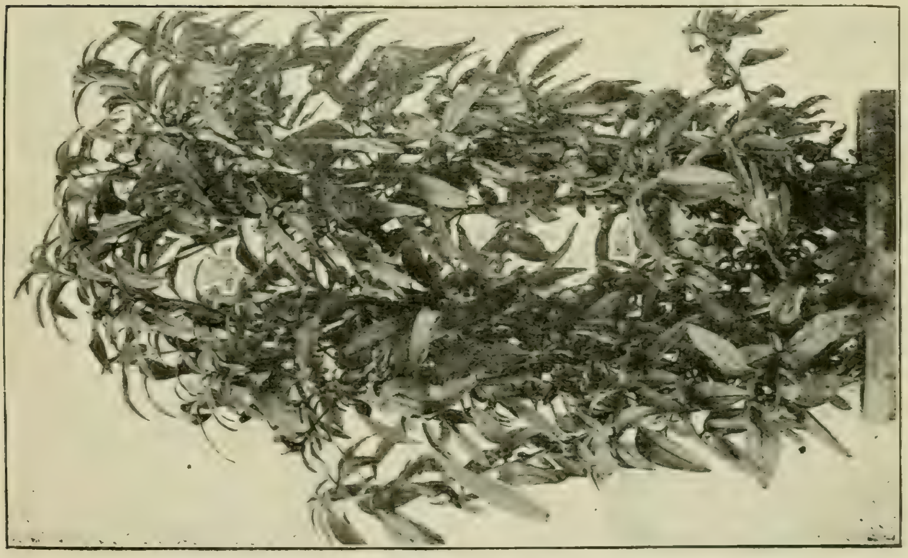


Fig. 2—Severely affected plant. Disease spread by method of watering. (Original).

Fig. 1—Illustrating the circular pustules on the underside of Snapdragon leaves. (Original)

Fig. 2—Severely affected shoot of Snapdragon. (Original)

Fig. 3—Rust sori on Calyx of Snapdragon. (Original)

surrounding the orchard. Raking up and burning such litter is good orchard practice and economy in spraying also.

In the application of the materials with which we spray there is considerable saving done and fungi prevented from propagating if in pruning we reduce reasonably the producing area of wood and thus open up the trees to admit sunlight and air.

2.—*Economy in getting the material on time.* There is nothing that is so discouraging to a fruit-grower than not to receive his insecticides or fungicides *on time.* There is no other way to avoid disappointment than to order these fully two months before actually going into the orchard with the spraying rigs. It is very bad *economy* to put off the ordering of insecticides and fungicides under the pretext that perhaps prices may come down. We risk too much in not getting the sprays on the trees on time in delaying so. Spraying must be looked at as an asset and an insurance which is abolutely needed every year for success in the orchard.

3.—*Economy in the spraying rig.*—There are spraying outfits suited for every orchard and it is bad economy to rely on a small hand-pump outfit for any orchard over 10 acres. There is such a thing as wanting to do things well with bad outfits. As success in spraying, and I mean the fact of spending so much time and money doing the work, depends on placing the material on the trees *on time,* how can you expect to go around any large orchard, do the work well and thoroughly, with a small outfit? There is no use spraying for codling moth after the calyx sepals have reunited on the small apples. This calyx spray in particular must be done thoroughly and quickly, and in very large orchards, I am of the opinion that a dusting machine may be necessary some years when time is scarce, on account of the soil being so sogged with rain water that a large spraying outfit can not be easily and quickly hauled over the orchard in time to treat all the trees. This is just one instance I mention here.

It is not good economy to wait until spraying time to overhaul the spraying outfits. At least a month before the actual time of spraying, the spray pump should be thoroughly overhauled and cleaned up. All worn and damaged parts should be replaced. This may require time to do, especially if it is necessary to get new parts from a distance. The nozzles, hose, rings of the "spray gun" also should be inspected and defective parts replaced. A coat of paint on the spray tank and pump will more than justify the expense and trouble. It is good economy also to have on hand extra parts that we know we may need during the spraying season. It is very *bad economy* to have to stop spraying one day or two, if not more, right in the height of operations, on account of some important part of the pump that does not work smoothly.

4.—*Spraying material.*—Here I am coming to the main point of this paper, and there are a few points that I wish to emphasize strongly today. There are too many spraying materials recommended to our fruit-growers and farmers to be able to spray economically to-day. It seems that some means should be found by our Society and by the Provincial Entomologist that could enable our farmers and fruit-growers to buy co-operatively all their *insecticides* and *fungicides.*

Even for such men as college professors and men who have done considerable spraying, I admit this for myself at least, it is quite a problem to decide where we will buy our insecticides and fungicides, what we will use so as to get the fullest possible benefit from and at the same time not pay too much for what we buy. I do not know if you have ever gone into the trouble of getting different quotations from the most reliable dealers of spraying materials. I have and it is surprising to find the difference which can exist in such prices. Here are a few exemples. (Read these on the original quotation slips).

Another point is this. Some of our farmers and fruit-growers are still using expensive material when we know, as a Society, that there is no use for such. I have not bought a pound of Paris Green for our orchard for 10 years. I am of the opinion that Paris Green should not be recommended, or even spoken of any more, in connection with the spraying of Potatoes, when we can have such an economical insecticide as arsenate of calcium which is safe with potatoes with or without Bordeaux, if we add 5 pounds of Hydrated Lime to 40 gallons of water. Paris Green just costs double the price of Arsenate of calcium in powder form. We have even dusted successfully acres of potatoes with a preparation of 10% Arsenate of calcium and 90% Hydrated Lime when bugs were too abundant, and with great success, without the least burning of the leaves.

AN IMPORTANT BIOCLIMATIC LAW

W. Lochhead, Macdonald College.

At the Annual Meeting of the Entomological Society of Ontario, held in Ottawa in November last, I presented a paper on "Hopkins' Bioclimatic Law" with the object of showing the value of this Law in the investigation of certain biological problems such as the distribution of the fauna and flora and the control of certain injurious insects.

The term "Hopkins' Bioclimatic Law" is not strictly correct for the Law was not discovered by Dr. Hopkins as he himself distinctly states in his monograph, *Supplement 9 of the Monthly Weather Review*. But he amplified the Law and applied it to this continent. By means of maps and charts he made it clear that it was possible by utilizing the information thus obtained to secure greater production of crops. In the matter of wheat production, for example, he was able to tell the farmers the best date to sow their wheat so as to escape the Hessian Fly and to get maximum production.

My object in bringing this Bioclimatic Law to your attention is to get your co-operation in the matter of the collection of phenological records for Quebec. Before charts can be made and the full details of the Law can be applied to this province, as Hopkins has done for many of the States, many thousands of reliable records covering a series of years must be secured from all parts of the province.

Fig. 1—Two leaves from mosaic diseased tomato plants. The characteristic growth is clearly shown. The bulging areas are a very dark green and the intermedite areas a pale yellow green. (Original).

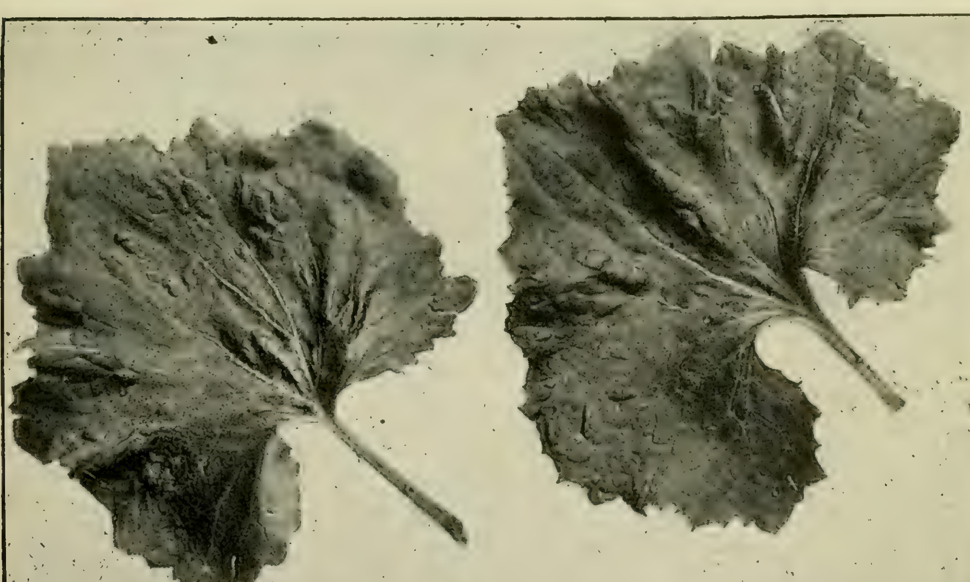


Fig. 2—Cineraria leaves from "Cactus" type showing darker areas bulging on upper side of leaf. (Original)

We have an interesting province from a climatic point of view for the great estuary of the St. Lawrence has an important influence in modifying the intensity of the larger controlling factors of latitude and altitude. I believe I am not too optimistic in stating that if the local influences of topography, exposure, prevailing winds, sunshine, rain, soil, etc., were thoroughly studied, many important improvements could be effected in the growing of crops. As Hopkins says: "There is a northern, southern, and altitudinal limit to the profitable culture of crops between which there is an optimum zone for the most profitable culture. By means of computing tables these limits and optimums can be approximately determined and shown on maps to serve as a guide to research and practice in determining the facts as related to regional and local conditions."

The Bioclimatic Law.

This law represents the "general laws of climate as affecting the seasonal activities and geographical distribution of plants and animals, periodical practices in Agriculture and the adaptation of farm crops to the requirements of climatic conditions." It may be stated as follows: The variation in the time in which periodical events occur in the seasonal development and habits of plants and animals, at different geographical positions within the range of their distribution is, *other things beings equal, at the rate of four days for each degree of latitude, five degrees of longitude or four hundred feet of altitude.*

Accordingly, lines running from the east toward the northwest at the rate of one degree of latitude to five degrees of longitude represent the same constant or average date of a periodical phenomenon for any given level throughout the length. Such lines Hopkins calls *isophanes.* He has constructed an isophanal map of the United States, with phenological meridians, five degrees apart but at right angles to the isophanes. By means of an accompanying chart for altitude he shows how constants may be computed, for the three combined factors, latitude, longitude and altitude. As the effect of local accelerating or retarding influences such as topography, lakes, large rivers, winds, etc., modify the computed average of the constant for each quadrangle, such departures for both spring and autumn have been determined and marked on each quadrangle of the isophanal map. Such determinations were based on 40,000 reports from all parts of the country on the beginning of wheat harvest.

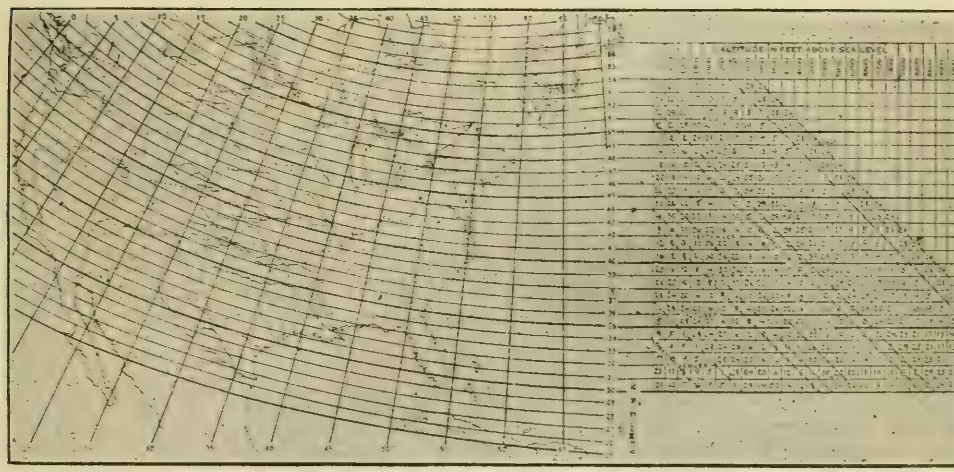
A detailed study of the altitude limits of species and of biological associations of plants and animals as mapped by the U. S. federal and state biological surveys served not only to verify the evidence furnished by the wheat harvest records but to establish, as a general principle, the approximate amount of variation we may expect to find in all regions from those in which there is no perceptible retarding or accelerating influence to those where the intensity of the influences reaches its maximum.

Isophanal Map of the United States in 5 degree isophanes and 1 x 5 degree quadrangles to illustrate method of designating phenological areas for the study of influences which contribute to time, attitude or latitude departures from the geographical constants. The estimated minus (earlier) and plus (later) departures in days from the computed time constant for spring and autumn events as given for each quadrangle, are based on a study of more than 40,000 reports on the date wheat harvest begins and on other statistics of planting and harvest dates for wheat, potatoes, etc., and represent averages for the entire quadrangle.

An Isophanal May of New York State with a chart for the determination of the best date for sowing fall wheat.

It will be observed that some of the departures (in days) are plus (later) and others are minus (earlier) than the computed average date. "In general, for the whole country, the departures for spring and early summer events are plus the constant for valleys and coasts, and minus for plains, plateaus and mountains; and the reverse for late summer and autumn events." (Figs.)

It is, of course, impossible at present to indicate the extent which this Law can be used in furthering investigations of insect and fungous diseases. Hopkins has shown that the Law has been of service in the control of the Hessian Fly and certain forest insects, consequently it is quite natural to suppose that other insects may also be controlled to better advantage by making use of this Law. It seems to me that if ever the method of Natural Control, discussed in my previous address, is to be employed on a wide scale, it must be based firmly on the Bioclimatic Law.



An Isophanal Map of the United States with annexed Chart to show best dates for fall wheat seeding in different districts.

Hopkins also suggests that the Law may be of service in the investigation and control of fungous diseases. The appearance of the earliest spring stages of many fungi, those largely concerned in the inoculation of plants, are dependent on climatic factors which, as we have seen, influence the time of leafing and flowering of plants.

Our spraying calendars are now based on phenological phenomena: this fact is but another evidence of the importance of relating farm and orchard operations to the Bioclimatic Law.

CAN WE IMPROVE POTATO STORAGE METHODS ?

P. I. Bryce, Macdonald College.

The potato stands next only to wheat as the source of the vegetable food in our diet. While the potato contains a high percentage of water, its flavor, its

simple culture, its abundant yield, and the apparent ease of caring for the harvest, place it high amongst our staple foods.

With the present soaring prices of food, it is an impressive fact that potatoes give a greater yield in weight per acre than any other food crop. Quebec had an area of 13,292,798 acres under cultivation in 1918, and of this 264,871 acres were planted to potatoes. The yield per acre was 147 bushels, the total yield 38,936,000 bushels, valued at $38,157,000.

Though in Canada, potatoes are mainly cooked fresh, a good quantity is boiled, shredded and dried, mainly for camp use. In the United States, the tubers find use as commercial potato starch, flour, and for making glucose, syrup, mucilage and sizing for paper. As a basis of industrial alcohol, the potato is largely used in Europe, and the smaller tubers form an important stock food. Quebec is likely to become more and more a source of seed potatoes, for which the climate is highly suited.

Canada has increased her yield from 75,300,000 bushels annually for the period 1909-1913, to 104,346,000 bushels, 1918, and 125,575,000 bushels in 1919. The United States have fallen back from a production of 411,860,000 bushels in 1918 to 357,901,000 bushels in 1919, and an increased market, it is seen, is opening for the Quebec producer.

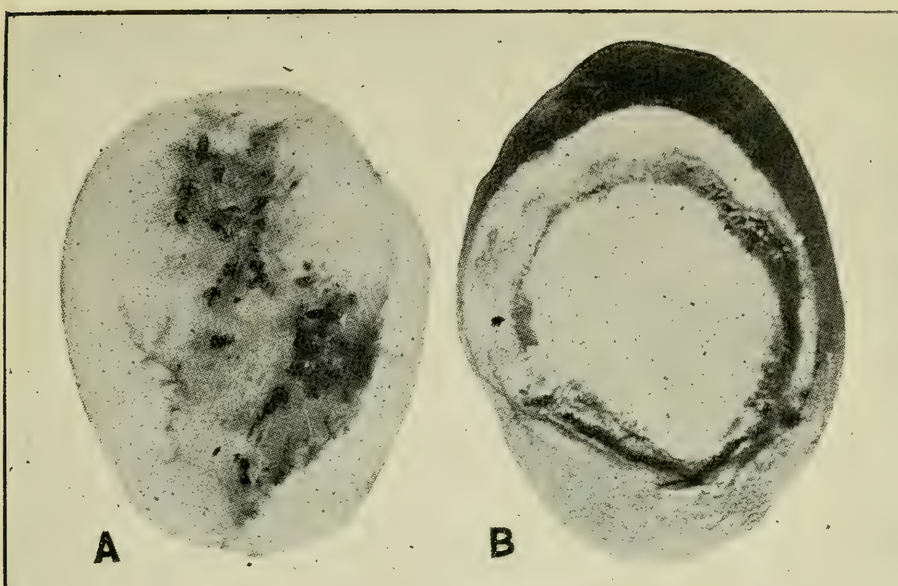
There is, then, a great and notable source of wealth in the potato, and the importance of conserving the annual harvest by proper storage methods, till it can be transported to its market, must be apparent.

We have heard and seen recently, indeed, that large as was the potato harvest in 1919, the amount of it available six months later, is far short of the demand. Potatoes sell at $6.50 a bag or more, and at that figure, the supply is scarcely equal to the demand.

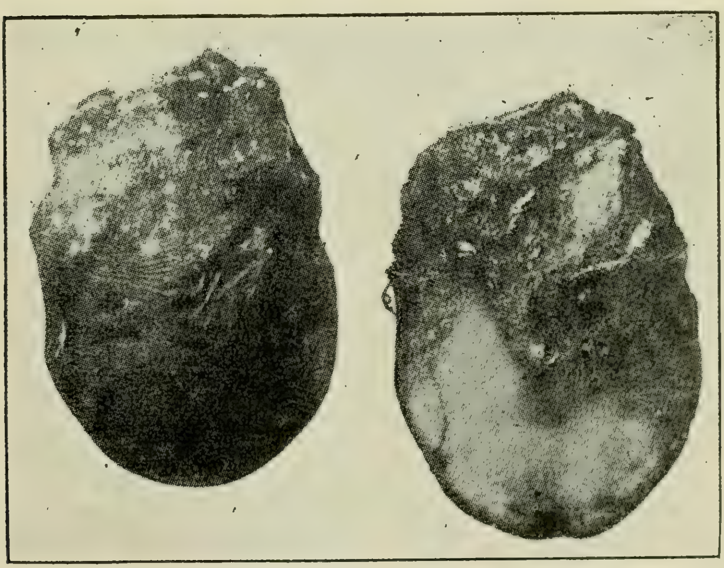
Much of this shortage is due, we believe, to shrinkage in storage where frost, decay and wilt have diminished the supply. Not less than 8-10% of the Canadian crop has thus been lost, a drop since harvest of 1,225,750 bushels. The estimated loss in the U.S.A. is 8% or not less than 13,047,968 bushels.

Diseases of Stored Potatoes.

While many diseases attack the potato in storage, particularly destructive are the parasitic fungous diseases, late blight and rot (Phytophthora infestans de Bary), dry rot (Fusarium sp.), the parasitic bacterial diseases, common scab (Actinomyces chromogenus Gasp.), and wet rots (Bacillus solanisaprus Harrison) and others. Other storage defects or maladies are classed as non-parasitic including frost necrosis or injury, black heart, and internal brown streak.



DRIED OUT NECROTIC LESIONS—Tubers found in storage in March which appeared perfectly sound externally. A—Net type of frost necrosis in which pitting has resulted from drying out. B—Ring type, very opaque discoloration, also pitted. (After L. R. Jones, M. Miller and E. Bailey, Frost Necrosis of Potato Tubers, Research Bull. 46, Agr. Exp. Sta. of the Univ. of Wisconsin).



Fusarium Dry Rot of Stored Potatoes. (After C. A. Zavitz, Potatoes, Bul. 239, Ont. Agr. College).

Characteristics of Diseases.

Late blight rot or potato disease is notorious as the cause of the potato famine of 1845 in Ireland. It is quite prevalent in moist autumns in Eastern Canada when it attacks the leaves and stems, thence invading the tubers. In the stored, infected potatoes, dry rot is the form taken by the disease. The skin exhibits darker brown, slightly shrunken areas, more than normally hard. Cut across, the flesh appears mottled with brown which spreads around the margin, gradually involving the whole tuber in decay. Soft rots may accompany dry rot. It must be remembered that infected seed potatoes carry the fungus with them to the field, to there reinfect the new crop, should the seed grow. Estimated losses from late blight and dry rot are, United States, $36,000,000 annually; New York, $10,-000,000 for 1912; for Prince Edward Island, $1,000,000 in 1915, when the disease was more than usually severe, and the damage done was on the same or a larger scale over Eastern Canada.

Fusarium Wilt and Dry Rot.

This "imperfect" fungus (Fusarium sp.) causes the trouble known as dry rot, end rot and bundle blighting. Infected seed gives seemingly normal plants which, however, wilt about blossoming time, and the vascular bundles of the stem are discolored. The roots are affected, and the young tubers often attacked at the stem end, with stem end rot. The fungus can rot potatoes under dry conditions but grows faster if it enters through wounds. It causes little injury at 32° to 36° F. The dry rot is a brown, compact, firm rot, without a foul odor. Cavities are often present, in which mycelium grows plentifully. Careful handling in digging, and storing is advised to avoid cuts and bruises. Clean and very cool storage reduces danger of diseases.

Wet or Soft Rots.

These decays are caused by bacteria, by a Sclerotinia fungus, and by black or blue molds, but potatoes are rarely attacked, except as a secondary infection. Taubenhaus describes a black rot or jelly end rot as caused by Fusarium radicicola Woll, "The stem end soft rots. The disease progresses inwards until the entire tuber within the skin becomes soft and jelly-like in consistency. The trouble is confined mostly to Idaho, Rural, and Pearl (varieties)."

Soft Rot and Black Leg.

Bacillus solanisaprus (Harrison) causes a drooping and shrivelling of leaves and stem, with black areas on petioles and stems near the ground. On tubers, "the skin shows reddish-brown discolored areas, something like a bruise, with a firm consistency," the flesh beneath turns soft. A black line marks off the healthy and diseased areas. "In the final stage the potato becomes a mass of black soft pulp". In storage, the rot spreads. Seed potatoes carry over the disease, and the

young plants become infected. Seed with brown discoloration should not be planted.

Black Heart.

In this non-parasitic disease there is discoloration of the central part of the tuber. Though it has been blamed upon overheating, experiments indicate the cause is lack of oxygen, as in potatoes stored in large piles. It is essentially a disease from imperfect ventilation.

Frost Necrosis.

The freezing point of the potato tuber is somewhat lower than 32°F., but below 30.7° F., 50-75% of potatoes tested froze. The resulting frost necrosis apears as a blackening of the water conducting tissue and is known as net, ring, or blotch necrosis. As setts, frost-injured seed gave only about 50% of a stand of normal production. Such injured seed thus must be planted twice as thickly, but badly frozen potatoes should not be used for seed. Rotten pieces must be rejected.

Suggestions on How to Store Potatoes.

Proved factors in good potato storage are control of temperature, of light, of air movement, and of humidity.

The temperature should be kept at 36°-40° F. All daylight should be excluded from storage places, but subdued light does not cause greening of potatoes.

Humidity may be kept fairly high at the low temperature. It prevents excessive loss in weight by drying. The percentage humidity must not be so high that moisture condenses on the potatoes.

Why ventilation ? Beucause pure fresh air kept in circulation maintains even conditions of moisture and heat, and a sufficient supply of oxygen. It is very difficult to control in pit or cellar storage. Air movement should be permitted as long as temperature is above danger point. An ordinary thermometer is a necessity in the storage place, to prevent risk of black heart and sweating.

Treatment before storage is not generally practised. It has been shown by Zavitz, however, that dusting sound potatoes and slightly decayed potatoes with hydrated lime reduced decay in stored potatoes to 0.8 per cent. for sound, and 40 per cent. for slightly decayed as compared to 4.5 per cent. of decay for sound untreated, and 58.3 per cent. of decay in slightly decayed. The length of storage was from November 7, 1912 to June 7, 1913, and November 23, 1915 to February 23, 1916. Twelve tests were made, and 5,000 tubers used, of three varieties. Treatment, then, appears profitable in years when rot in severe as in 1912 and 1915.

Temporary Storage.

It is sometimes necessary to store potatoes temporarily in the field. The potatoes should be placed in piles in a dry part of the field, covered with straw, with a little earth thrown over it. Add more straw and earth in cold weather.

Cellar Storage.

Potatoes should be dug as soon as the tops have died, and as far as possible before there is danger of much soil freezing. They should be dried for a day in the open air, and stored away in boxes, crates, barrels or small bins in the cellar. Room for air circulation must be given, allowing not less than 4 inches space between bins. Storage should be arranged for in the coolest and best ventilated room of the cellar. It is essential that it be possible to exclude cold air in midwinter so that no danger of frosting be incurred. A room on the north side permits exclusion of the sunlight. Ventilation can be carried on in the fall by means of a window; and a slide in a double window on the outside during the winter. It is better to use a ventilating chute or air duct carrying cool fresh air to the floor. Put a damper in the air duct. A hinged or slide door in the sash can be used as outlet for warm air. The window must be darkened somewhat to prevent growth. Most roots can be safely stored in the same room and help to maintain suitable moisture conditions.

Commercial Storage.

With greater quantities of potatoes to be stored more definite provision for aeration and protection is required. Various types of storage are used such as dug-out pits or root-houses, insulated frame structures, and cold storage houses. Where potatoes are the main crop as in Aroostock Co., Me., and in parts of New Brunswick, large houses with a drive down the middle and bins on each side are used.

For the farmer, the dug-out pit or root-house is of ample size and can be adopted to conditions admirably. The full length of the store house may often be dug in the side of a hill or the slope near the barn. It should be placed in as dry and convenient a situation as possible. Make the excavation the size of the cellar, using the soil taken out for covering the roof and banking the sides. Set two rows of posts of uniform height in the bottom of the pit near the dirt walls, and a third line of posts about five feet higher along the centre of the pit. On these posts is supported the planks forming the roof. Make double doors at one end, and put a ventilator in the roof. On the roof, place sod, then soil, and add a layer of strawy manure, one to four feet thick to keep out frost.

The potatoes are placed best in aerated crates or bins with ventilated partitions, on a false floor two or four inches above the dirt, board, or cement floor.

The false floor of the bins is made of 7-8 x 4 inch slats laid one inch apart, on 2 x 4 inch sills. Division walls should be of 2 x 4 inch uprights on the 2 inch side of which are nailed 7-8 x 4 inch strips, leaving a one inch space for ventilation. Bins should thus have a 4 inch space separating them. For the front of the bin movable 7-8 x 4 inch strips fitting in grooves attached to the uprights are used. The strips may be put in gradually as the bin is filled. Such a bin gives ventilation, ease in getting potatoes out, while cleaning each summer is easily done. This bin has proved a success at Macdonald College, and is in use by the U. S. A. Dept. of Agriculture.

Bearing in mind some of the points suggested we find that the potato ranks next to wheat as a food. Quebec produced 38,936,000 bushels worth $38,157,000 in 1918. At the Central Experimental Farm, Ottawa, potatoes have been produced on a small plot at the rate of 722 bushels per acre.

The annual loss through shrinkage, frost, decay, and wilt in storage is believed to be 8 to 10% of the annual crop.

Improperly stored, or diseased potatoes are subject to a member of preventible diseases. These are in general parasitic fungous and bacterial diseases, and non-parasitic troubles. Diseased, bruised, frosted, tubers should not be stored with sound potatoes.

Diseased potatoes may be sprinkled with hydrated lime, and if carefully stored rot is less than with untreated potatoes. Potatoes should be picked over and the diseased removed from time to time. Diseased seed should not be used. It is partly worthless and spreads the trouble in the field. Unsound tubers should not be sold unless marked plainly.

Important factors in good storage are a temperature of 36-40° F., exclusion of sunlight, good ventilation, but protection from frost, and fairly moist conditions.

Potatoes temporarily stored in the fields should be carefully protected from frost and rain.

In cellar storage, the use of small rather than large containers or heaps is advisable.

For the commercial grower, the dug-out or partly underground storage may well be used. A frost proof house is an essential, and this requires insulated walls. The insulation may consist of strawy manure outside. Ventilation is necessary in fall and spring. Easily ventilated crates or bins are better than storage on the floor, to avoid dampness, and black heart.

Finally, careful shipping pays. Pack well and avoid rough handling. Bruising and shaking in transit should be prevented. Ship in clean, tight cars which must be warmed in winter.

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Quebec Society for the Protection of Plants

1920-1921

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THIRTEENTH ANNUAL REPORT

Quebec Society for the Protection of Plants

1920 - 1921

To the Honourable J. E. Caron, M.P.P.,

Minister of Agriculture,

Quebec.

Sir :—

I have the honour to present herewith the thirteenth Annual Report of the Quebec Society for the Protection of Plants, containing the proceedings of the winter meeting of the Society, which was held at Macdonald College, Ste. Anne de Bellevue, Que., on the 1st of March, 1921.

Included are the papers that were read, and the reports of the officers of the Society.

I have the honour to be,

Sir,

Your obedient servant,

B. T. DICKSON,

Secretary-Treasurer

Macdonald College, Quebec.

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Rev. Father Superior, La Trappe.
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Canon V.A. Huard, DSc., Quebec.
Rev. Father Superior, Ste. Anne de la Pocatière.

FINANCIAL STATEMENT FOR 1920-21

Receipts

Brought forward	$127.58
Provincial Government grant	250.00
Interest on deposit	5.98
	$383.56

Disbursements

Lecturers and delegates	$ 51.42
Delegates to Ont. Entom. Soc.	81.65
Delegate to Canadian Phytopath. Soc.	41.00
Printing programs	7.07
Secretary	50.00
	$231.14
Balance in bank, May 16, 1921	152.42
	383.56

NOTE.—Postage and stenographic account not included.

Auditor :—

E. MELVILLE DU PORTE.

B. T. DICKSON,

Secretary-treasurer

W. LOCHHEAD,

President.

QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS

REPORT OF THE WINTER MEETING

The thirteenth annual meeting of the Quebec Society for the Protection of Plants was held in the Biology Building of Macdonald College, on Tuesday, March 1st 1921.

Business Meeting

The business meeting was opened by the President, Prof. W. Lochhead, at 2.00 p. m. Among those present were :—Rev. Father Leopold, Dr. W. T. MacClement, Dr. F. C. Harrison, Dr. J. C. Chapais, Prof. Dickson, Prof. Bunting, Prof. Letourneau, Prof. McRostie, Mr. A. Gibson, Mr. L. S. McLaine, Mr. C. E. Petch, Mr. Winn, Mr. Coderre, Mr. Blair, Mr. MacMahon, Mr. Grindley, Mr. Maheux, Mr. Caron, Mr. Roy, Mr. Crawford, Mr. Kelsall, Mr. Tawse, Mr. Howitt, Mr. Saunders, Mr. Milne, Mr. Hockey, Mr. Hethrington, Mr. Major,Mr. Richardson, Miss D. Newton, Mr. Simmonds and others.

The minutes of the last meeting were approved.

The report of the treasurer was read and accepted.

The following were the officers appointed for the following year :—

President :—Prof. W. Lochhead, Macdonald College.

Vice-President :—Rev. Fr. Leopold, La Trappe.

Secretary-treasurer :—Prof. B. T. Dickson, Macdonald College.

Directors : Rev. Dr. Fyles, Ottawa.
Prof. Letourneau, La Trappe.
A. F. Winn, Esq., Montreal.
Rev. Prof. Fontanel, Montreal.
G. Maheux, Esq., Provincial Entomologist, Quebec.
G. Chagnon, Esq., Montreal.
Prof. G. Bouchard, Ste. Anne de la Pocatière.
Dr. A. T. Charron, St. Hyacinthe.

Auditor :—E. Melville DuPorte, Macdonald College.

Delegate to the Royal Society of Canada., Prof. W. Lochhead.

Delegates to the Ontario Entomological Society : Prof. W. Lochhead, and either Mr. H. Roy or Prof. Bouchard.

Delegates to the Canadian Branch of the American Phytopathological Society : Prof. B. T. Dickson and Prof. Letourneau.

It was resolved that the Society, so far as funds are available, continue to help in aiding investigations concerning economic diseases caused by insects, fungi, or bacteria.

A communication from the British Columbia Entomological Society was read by the Secretary regarding proposals for the publication of entomological

articles. It was decided that, in view of the fact that our Society serves as a medium for more than papers dealing with entomological questions, the matter be kept under advisement until the next annual meeting.

It was decided to hold the summer meeting at the discretion of the Executive.

GENERAL SESSION

The general session of the thirteenth annual meeting was opened at 3.00 p. m. in the Biology Building of Macdonald College, by the President, Prof. W. Lochhead.

Dr. F. C. Harrison, Principal of Macdonald College, extended a cordial welcome to the visitors and delegates. The addresses and papers are printed in detail in the body of the Annual Report. The guests of the Society were Prof. H. H. Whetzel, head of the Department of Plant Pathology of Cornell University, Dr. W. T. MacClement, Professor of Botany at Queen's University, Kingston, and Mr. A. Gibson, Dominion Entomologist, Ottawa. Mr. Gibson gave a very interesting talk on the work and equipment, both material and personal, of the Dominion Entomological Service. His talk was well illustrated by lantern slides.

ADDRESS OF WELCOME

By Principal Harrison

It gives me great pleasure indeed to have with us again the visitors and delegates to the Society. At previous meetings we have had a number of representatives from the Experimental Farm at Ottawa, from our friends at Oka and Quebec, and also, as a rule, a distinguished visitor or two from the great Republic to the South of us, and this year is no exception to that rule. Among those from Ottawa is the new Dominion Entomologist in his official capacity and we congratulate him on his appointment to this post and give him a special welcome ; Father Leopold from Oka and representatives from the Quebec Department of Agriculture are also present, and we are glad to see them and meet them on the common ground f the subjects taken up by the Society.

We are particularly pleased on this occasion to welcome Professor W. T. MacClement, of Queens University, and Professor Whetzel, of Cornell University. Cornell has always kept in touch with Canadian Institutions—especially Institutions of Agriculture. A large number of our staff have studied at Cornell so that when we have visitors from that University, we do not look on them merely as visitors, but have a much warmer feeling for them. As a postgraduate

student of that University I am glad to welcome its distinguished representatives. It is many years since I was at Cornell, but there are many members of their excellent teaching staff whom I remember with pleasure—Professor Atkinson, Dr. Rowlee, Professor Comstock and his inestimable lady—these have helped a great many of us and have left a lasting impression for the very hospitable welcome always given Canadians. I was only speaking a short time ago about Mrs. Comstock and I made the remark that she was the only American lady I knew who could ever attempt to run a salon.

This society accomplishes a great work in that it brings together a large number of distinguished individuals. When these specialists meet and exchange views, they brush away some of our mental cobwebs and give us new views, and after they have gone we want to go to work with redoubled energy. We welcome the opportunity of meeting these specialists, for frequently conventions are held so far away that it is difficult for members of this institution to attend them. It is an inspiration to meet others working along the same lines, so we welcome this gathering of experts, both for its influence on those members of our staff who are engaged in similar lines of work, and for the opportunity it offers to our senior students to gain new viewpoints.

Since last meeting there have been some changes which I should like to refer to as briefly as possible. We had here formerly Botany and Entomology under one Department, but last fall these have been placed in separate departments. In small institutions it is difficult to arrange for full specialisation. We have not reached the standard of Cornell University in graduate study and specialization, but the governors of McGill University are going to encourage research work in agriculture, which is a great advance. We are getting demands from the Dominion Department of Agriculture and other institutions for experts, research men and teachers, who shall be better trained and better able to work independently on particular problems. We also feel that those engaged in teaching should be not only well grounded and know their special subject, but also be able to teach it, and hence we are paying more attention to pedagogical aspects, and have also endeavoured to teach the writing of articles for newspapers.

Such visits as those of our friends are most acceptable for bringing inspiration to this work and for giving the students an opportunity of hearing men distinguished in the fields of Plant Pathology and Entomology.

The "Pièce de Resistance" of this evening's programme is the address by Professor Whetzel, so I shall say no more, except to again welcome you very heartily.

PRESIDENT'S ADDRESS

THE STORY OF SPRAYING MIXTURES

W. Lochhead, Professor of Entomology and Zoology, Macdonald College, P. Q.

Prior to 1860 the methods of protection of plants from insects and fungous diseases were extremely crude and primitive. Practically nothing was known about the nature of fungous diseases, and although insects had been studied for many years, no serious attempt had been made to control the injurious forms with chemicals. The best insecticides in use were various forms of soap, tobacco, quassia chips, carbolic acid and hellebore.

As we all know, spraying mixtures are of two kinds : — *Insecticides* and *Fungicides*, but some mixtures, like lime-sulphur and soluble sulphur, belong to both groups.

Insecticides

In the development of insecticides, as of other phases of economic entomology, the United States has taken the lead over all other nations. Two outstanding factors contributed to this wonderful progress :—1. The losses which certain portions of the country suffered at various times from (a) the potato beetle ; (b) the Rocky Mountain locust ; (c) the cotton caterpillar ; (d) the San José scale ; (e) the cotton-boll-weevil ; (f) the Gypsy and Brown Tail moths, brought public opinion to bear strongly upon Congress so that measures were taken to discover methods of control ; 2. The establishment of State Agricultural Colleges and Experiment Stations which made it possible to train men for the investigation of such problems.

It is interesting to note that, in the matter of insecticides, methods of fumigation with hydrocyanic acid gas, and spraying with lime-sulphur and resiny washes were developed first on the Pacific Coast, while arsenical sprays and mineral oil preparations were developed in the East.

Paris Green.—Paris Green was the first insecticide of merit to be employed against biting insects. During the sixties, it came into use against the Colorado beetle, in the seventies it was successfully used against the cotton caterpillar and against canker-worms and the codling moth in orchards, and in the eighties against the plum curculio and other pests. By 1890 Paris Green had become the standard insecticide against biting insects. However, this and other arsenite compounds, like London Purple and the Kedzie mixture made from white

arsenic, were soon found to be unsatisfactory on account of their liability to burn foliage unless great care were taken to neutralize the free acid present.

Arsenate of Lead.—In 1892, Arsenate of Lead was first employed against the Gypsy moth, and gradually gained favor as a substitute for Paris Green. It has the advantage of being harmless to foliage, of remaining well in suspension without constant stirring, and of sticking to the foliage for a long time. It can, moreover, be used with Bordeaux and lime-sulphur as a combination spray. As the paste form deteriorates on exposure, while the powder is quite stable, the latter is recommended for general use.

Sanders and Kelsall, of the Dominion Entomological Laboratory, Annapolis, Nova Scotia, have done some admirable work on the reactions that occur when arsenate of lead is mixed with other chemicals. For example, they found that apple foliage is liable to be injured when more than 15 mgms. of As_2O_5 are in solution per 1000 cc. of water. In the case of lead arsenate ($PbH\ AsO_4$) it is seldom soluble to the extent of 4 mgms. of As_2O_5 in 1000 cc., and on the average about 2 mgms. However, when the manufacturer adds a small amount of MgO to make it float better in water, a chemical reaction occurs which makes it dangerous to leaves. Magnesium arsenate ($Mg\ H\ AsO_4$) is formed, which dissolves to such an extent in water that 40 or 50 mgms. of $As_2\ O_5$ are to be found in 1000 cc. of water.

Again, when a very small quantity of lime is added to lead arsenate, a lime arsenate ($Ca\ H\ AsO_4$ is formed which is highly dangerous. But if the lime be present in large quantities $Ca_3\ (AsO_4)$ is formed which is not dangerous.

Arsenate of Lime.—During the last two or three years, arsenate of lime has been employed by many growers as a substitute for the lead arsenates, on the score of reduced price and higher poison content, pound for pound. It is, however, less stable, but with the addition of a stabilizer such as hydrate of lime, Bordeaux, lime-sulphur, or soluble sulphur, when excess lime is present, it is quite safe to foliage.

For the coming year arsenate of lime is being widely recommended as a cheap and effective substitute for arsenate of lead.

Lime-Sulphur.—Perhaps the most outstanding achievement in commercial spraying during the last forty years has been the introduction and improvement of lime-sulphur. In the eighties the California fruit growers used it against both the scale and the peach leaf curl. As an insecticide against scale and many sucking insects, it has been employed ever since, but, by the early method of preparation, it had to be applied warm for crystals soon formed, which tended to

clog both the spray pump and the nozzles. Moreover, it could be used only for the dormant or semi-dormant stage.

About 1912, a new method of preparation was discovered, which removed the objectionable features of the old method. It consisted in making a concentrated solution by boiling together 50 lbs. of fresh stone lime, 100 lbs. of sulphur and 40 to 50 gallons of water.The solution when properly made can be kept for months, and for use can be readily diluted to any strength required for dorant and summer spraying.

The discovery by Sanders and Kelsall of the cause of the heavy drop of the fruit after applications of lime-sulphur is worthy of note. They found that when lime-sulphur (1 to 30) was applied only to the upper surface of the leaf no injury followed, but when both sides, or only the lower surface were sprayed, injury was done. When sprayed leaves were examined miscroscopically it was observed that the chlorophyll of the leaf-cells had been acted upon by an appreciable amount of lime-sulphur absorbed through the lower surface. They observed, however, that no such injury followed applications of Bordeaux and soluble sulphur.

The excessive dropping of the fruit, they maintain, is due to the injury to the leaves whereby they fail to function as carbohydrate manufacturers for the fruit. The greatest drop occurs after the fourth application, that is, the one given two weeks after the petals fall, and has only become evident since the advent of high-pressure pumps and greater capacity nozzles.

Another important investigation by Sanders and Kelsall bore on the question of the influence of fungicides on the killing value of poison insecticides when the two are mixed together. They found that with Bordeaux the average poison is decreased in value by about 50 per cent. With soluble sulphur, the value of the poison is increased from 10 to 15 per cent, and with lime-sulphur the decrease is about 20 per cent.

Kerosene Emulsion.—A solution of Kerosene Emulsion has long been a valuable insecticide against sucking insects. The standard formula (Riley-Hubbard) was originated in 1884, although several modifications have also appeared. When properly prepared Kerosene Emulsion can be applied with safety on most plants, but of late years tobacco extracts have taken its place.

Tobacco Extracts.—Tobacco dust and extracts have been used probably for more than a hundred years for the control of aphis and other sucking insects, but it is only within the last ten years that concentrated extracts of nicotine have been placed on the market. The best known of these are "Black Leaf 40", being a 40 per cent solution of nicotine sulphate, a non-volatile substance, and

"Nicofume", a 40 per cent solution of nicotine in the volatile form. Black Leaf 40 can be combined with lime-sulphur, Bordeaux and arsenates of lead and lime as a 3-in-1 mixture, and is used at strengths varying from 1 to 800 to 1 to 1600 of water.

Fungicides

It is not surprising that plant growers of two or more generations ago had difficulty in controlling plant diseases, since the nature of these maladies was not understood. One has but to peruse some of the old works on the nature and treatment of disease to find how crude were the conceptions of the early plant growers and botanists, and how far the modern plant pathologist has travelled during the last fifty or sixty years.

Three outstanding factors contributed to the great development of our knowledge of plant diseases and methods of control :

1.—The epochal investigations of European botanists on the causal organisms and their relation to such plant diseases as smut (1853), the potato-rot disease (1861), and wheat rust (1865).

2.—The rise of American investigators in the seventies and eighties, such as Burrill, Farlow, Arthur, Bessey, Halstead, Earle and others whose contributions added substantially to our knowledge of fungi and of fungous and bacterial diseases.

3.—The work of the U. S. Department of Agriculture and of the newly established Agricultural Colleges and Experiment Stations which gave a tremendous impetus to the study of plant diseases and control measures from 1885 onward to the present.

It is true that sulphur and powdered lime were often dusted upon the plants and gave some relief, but it is only since the discovery of Bordeaux in 1883 that the control of plant diseases has been carefully investigated. The plant pathologist has shown clearly that the fungicide should be applied just before the rain, not after. In the case of apple scab, for example, the spores are carried to the leaves during rains, and if the rainy spell lasts 48 hours infection will take place. To protect the leaves, therefore, the spray must be applied before the rain.

Again, the plant pathologist has shown clearly that a knowledge of the life history of the fungus is essential if best results are to be secured in spraying operations.

Lime-Sulphur.—Lime sulphur has already been mentioned among the insecticides, but it is also one of the best fungicides. For a time after the discovery of Bordeaux mixture it was discarded, but in 1906 its importance as a fungicide was rediscovered, and ever since it has been employed extensively for the control of many fungous diseases of the orchard.

In Nova Scotia, however, the fruit growers observed that the calyx spray and especially the following spray were responsible for a heavy fall of fruit on account of its action on the leaves. For this reason they substituted in 1918 and 1919 a modified Bordeaux for the lime-sulphur.

Lime-sulphur is in the main a mixture of polysulphides of calcium. The fungicidal properties of lime-sulphur lie in the free sulphur that is formed on the surface of the leaves and fruit on the evaporation of the water and the oxidation of the polysulphides.

When trees have been drenched with the mixture, injury is liable to occur, but under proper conditions little or no injury follows, except in the case of potatoes, American grapes and some varieties of peaches.

Bordeaux Mixture.—From the time of its discovery by Prof. Millardet, of France, in 1883 up to 1910, Bordeaux mixture was the standard fungicide for summer spraying. But with the rediscovery of lime-sulphur in 1906 as a summer spray, Bordeaux has been relegated to second place in commercial orcharding on account of the russetting of the fruit and the yellowing of the foliage that followed the standard application, made according to the formula 4:4:40.

The stucture and composition of Bordeaux mixture has been recently ascertained. It consists of colloidal membranes composed of a complex mixture of basic copper sulphates, enclosing a solution of calcium hydroxide and calcium sulphate holding lime particles in suspension. The fungicidal properties depend on the number and size of the colloidal membranes and on the lime particles. The smaller the membranes, the more effective does the mixture cover the sprayed surface. When evaporation of water occurs, the minute membranes dry down and attach themselves firmly to the surface. Then the copper in the membrane is slowly dissolved when the leaves become moist, and either kills or inhibits the germinating spores which lodge on the leaf. Moreover, it is believed that the lime particles are also fungicidal.

It will be seen, therefore, that the quality of the Bordeaux depends upon the method of preparation.

The minute membranes will never be formed when concentrated solutions of Copper sulphate and milk of lime are brought together. On the other hand, they will be formed when vigorous stirring takes place when the dilute solutions brought together.

Reference has already been made to the peculiar conditions in Nova Scotia, which compelled the fruit growers to return to a modified form of Bordeaux where lime is used in excess. In 1919 they used the 3 :10 :40 and the 2 :10 :40 formulæ with gratifying results.

Dust Spraying

While dust spraying was probably employed before liquid spraying, it was superseded by the latter when Bordeaux mixture and Paris Green became the standard spraying materials. However, as fruit growing was developed more extensively, and intensively as well, the factors of economy of time and cost of equipment in spraying operations assumed more importance, and efforts were made by the more progressive men to meet the needs of the industry by devising more economical methods of spraying.

About 20 years ago sulphur dusting was tried occasionally on grapes, but about 1911 orchard experiments in dusting were begun in New York State by Cornell Station. These were continued for about seven years or until it was conclusively demonstrated that dusting was both efficient and practicable, and a satisfactory substitute for liquid spraying.

Nova Scotia furnishes an interesting example of changing methods in spraying, due to the investigations by Messrs. Sanders, Kelsall and Brittain. These gentlemen have devised improved mixtures for both liquid and dust spraying. Up to 1912 Standard Bordeaux was the fungicide used by the fruit growers ; then lime-sulphur was substituted. When this proved unsatisfactory a modified Bordeaux with an excess of lime was employed.

Dusting was introduced about 1916, and gradually made headway with improvements in the manufacture of dust products. In 1918, 1919 and 1920 the 90-10 sulphur arsenic dust (90 per cent sulphur and 10 per cent lead arsenate) and copper arsenic dust (10 per cent copper sulphate, 5 per cent arsenate of lime, and 85 per cent hydrated lime) were used. In 1921 both the sulphur and the Bordeaux methods will be used by the fruit growers of that province.

Up to 1920 no dusting material has been found that controlled sucking insects satisfactorily, but the 1920 experiments in California against the Pear Thrips, with 5 per cent "Nico dust" which contains 5 per cent Black Leaf 40 and pulverized Kaolin, and those in Nova Scotia against psyllids with nicotine sulphate with sulphur and arsenate of lead, give strong hopes that the difficulty has been largely overcome. It will be possible for the future to use a 3-in-1 combination dust against fungi and biting and sucking insects.

In this very incomplete review an attempt has been made to make clear the chief outstanding events in the story of spraying mixtures. These are :—

1.—The use of Paris Green against biting insects, between 1860-1870.

2.—The introduction of Bordeaux mixture as a fungicide, about 1885.

3.—The introduction of lime-sulphur, first as a contact insecticide and later as a fungicide in 1906.

4.—The use of lead arsenate and calcium arsenate as insecticides against biting insects.

5.—The use of Kerosene emulsion and tobacco extracts as contact insecticides.

6.—The practicability of combining the more important insecticides and fungicides in one mixture for spraying purposes, thus saving much time in spraying operations.

7.—The manufacture of spray materials in finely powdered form and the introduction of dust-spraying, making for much saving of time.

8.—A better knowledge of the chemical reactions that occur when different spraying materials are brought together, and of the physiological action of these mixtures on the leaves of plants.

9.—A better knowledge of the life history of insects and fungi, so that the spray applications are made at times when they will be most effective. In other words, the spray calendars are now based on the stage of development of plant, insect and fungus, and not as formerly on the almanac.

10.—Closely connected with developments in spraying is the development of spraying outfits, which this paper does not attempt to discuss.

In conclusion, it is a pleasure to note the part taken by Canada in the story of spraying mixtures, although she has in most cases followed the lead of the United States and Europe.

Mention has already been made of the splendid investigations carried on in Nova Scotia by Sanders, Kelsall and Brittain in connection with lime-sulphur injury, and with the making of dust mixtures, but credit should be given to Saunders and Reed, of London, Ontario, for their early experiments (1871) with various chemicals for the control of the potato beetle, to Cline, of Winona, and McMichael, of Waterford, for their experiments with orchard insecticides and fungicides from 1883 to 1887, to Prof. Craig, of the Dominion Experimental Farm, for experiments on the control of apple scab and other diseases with Bordeaux and other fungicides (1890-1894), to Dr. Fletcher for his experiments on the control of many injurious insects, and to the Ontario Agricultural College for experiments with lime-sulphur and other substances against the San Jose scale.

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REPORT OF THE DELEGATE TO THE CANADIAN BRANCH OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

Prof. B. T. Dickson

The second annual meeting of the above Society was held in the Biological Building of the Ontario Agricultural College, on December 9th and 10th, 1920. There was an excellent attendance of members from as far west as Saskatoon and east from Montreal.

Dr. Buller, of Winnipeg, was in the Chair, with Dr Reddick, of Cornell University, as the Society's guest.

The President, in an able address, discussed the losses which constituted an annual tax on the growers and cited specific statistics in the case of the most important diseases.

Dr. Reddick, in a public evening address, showed that most of the great results in plant pathology were the outcome of quiet, thorough research. These were then applied to the practical side of the science, so that benefits accrued, but in most cases those who thus benefitted knew little or nothing of the pioneer research. The science is still a young one, but much good work is being done and there are plenty of fields of endeavour for the future. It is of prime importance, however, to look carefully to the training of those who are going to undertake the work that only the best may be done.

Prof. Dickson gave an illustrated paper on mosaic diseases, dealing with the list of plants at present known to suffer from mosaic. This included clovers, potato, tomato, tobacco, violet, etc. It was pointed out that symptomatically raspberry is a member of this list and it is possible that, in the past mosaic and curl, or yellows, have been confused. Histologically also this type of raspberry disease falls in the mosaic class. It remains to be seen whether curl is an advanced stage of the raspberry mosaic. Work is in progress at present on that problem.

Prof. Fraser reported the work done by himself, Miss M. Newton and Mr. Bailey on biologic forms of the black stem rust of wheat in Western Canada. Using Stakman's method and tabulation strain IX is found at Saskatoon, XV in one locality, XVII mostly in Saskatchewan, XVIII at Riverstone, Saskatoon, etc., XXI at Winnipeg, Brandon, Edmonton, etc. Strain XV attacks all differential hosts. Kanred and Emmer are resistant to XVII and Marquis is resistant to XIX. It is not intended that this be considered a full report of Prof. Fraser's paper.

A new disease of strawberry was described by Dr. Stone as a Mollisiose. It has occurred during the last two years in Ontario from Sarnia to the east and is most prevalent on Clyde and Glen Mary varieties. Senator Dunlop and New Williams are both free from this disease.

It is symptomatically called "leaf scorch," owing to the effect on the leaves. At first minute purplish spots 1-6 mm. appear and later they enlarge and coalesce. As the disease progresses they become ashy colored and acervuli develop. Elongated purple spots also appear in the petiole.

Systematic studies show that the ascogenous stage is *Mollisia earliana E. and H.* The fungus overwinters on green mulched leaves and the ascospores are disseminated from April to June.

Control is possible by destroying old, diseased leaves and by spraying with Bordeaux.

Prof. Howitt gave a comprehensive account of three years' work on the dry formaldehyde treatment against oat smut. He found little injury to germination except in old oats with impaired vitality. In 1918, 61 bushels were treated resulting in treated plots being free from smut while check plots had 8.6% smut.

In 1919, 600 bushels were treated giving a negligible amount in treated plots as against 6.3% smut in untreated seed.

In 1920, 1016 bushels were treated and divided into 30 widely scattered trial plots. The results varied since check plots showed none to 14% smut.

The results are entirely satisfactory and especially when one considers speed of application. One hundred bushels can be treated in 50 minutes. In one instance oats were kept three weeks after treatment without injurious effects.

Dr. Rankin and Prof. Fraser reported on the work of the Plant Disease Survey for the year. Requests for collaboration and individual reports were sent to all likely to be interested, but unfortunately the number complying was small. Many areas were, however, well covered and from these conclusions can be drawn. It is hoped that during the ensuing year better results will be achieved. The Society expressed its appreciation of the work accomplished in so short a time by Dr. Rankin and Prof. Fraser and they were reappointed a Committee in charge for 1921.

Dr. Buller gave three illustrated and interesting talks. In the first he detailed experiments he had carried on to show that slugs were attracted to and carried spores from certain members of the Phalloideae.

He also discussed the phenomena of spore discharge in the Discomycetes, explaining that this discharge is audible if the Discomycete be held close to the ear.

Mr. Duff dealt with the development of the fruit body in the Geoglossaceæ and illustrated his talk by blackboard diagrams.

Dr. Faull delivered a very interesting talk on *Fomes fomentarius*, explaining how it could be cultured in the laboratory and giving a detailed account of the pathological effect on the host trees.

Prof. Caesar made a strong plea for more extension work, maintaining that we did not need so much research to-day as we did need the dissemination among farmers and fruit growers of the facts made known during the last ten years. Prof. Cæsar explained that he did not intend to imply that research should cease.

The Society closed a useful and interesting session with the following officers for the year 1921 :—

President	J. H. Faull.
Vice-President	W. H. Rankin.
Sec.-Treas	R. E. Stone.
Councillors	A. H. R. Buller.
	B. T. Dickson.

The official program is appended.

Thursday—December 9th

Meeting of the Council—11.00 a. m.	
President's Address—2.00 p. m	A. H. R. Buller.
Appointment of Committees	
Studies in Mosaic (Illustrated)	B. T. Dickson.
Biologic Forms of Wheat Stem Rust in Western Canada	Margaret Newton.
Biologic Forms of the Wheat Stem Rust in Western Canada	W. P. Fraser.
Leaf Scorch or Mollisiose of the Strawberry	R. E. Stone.
Results of Three Years Experiments with the "Dry Formaldehyde Method" of Treating Oats for Smut	J. E. Howitt.

Evening Programme

Address of Welcome.—President J. B. Reynolds.
The Trend in Plant Pathology.—Dr. D. Reddick.

Friday—December 10th

Election of Officers—9.00 a. m.
Report of Committees.
Appointment of Committees for Coming Year.
General Business.
Report on the Plant Disease Survey............W. H. Rankin, W. R. Fraser.
Upon the Chemotactic Attraction of Fungi for Slugs (Illustrated)............A. H. R. Buller.
The Sound Made by Fungus Guns and a Simple Method for Rendering Audible the Puffing of Discomycetes (Illustrated)............A. H. R. Buller.
Development of the Geoglossaceae............G. H. Duff.
Studies in Fomes fomentarius............J. H. Faull.
Relation of Plant Pathology to the Farmer and Fruit Grower............L. Caesar.
Upon the Ocellus Function of the Subsporangial Swelling of Pilobolus (Illustrated)............A. H. R. Buller.
Observations of Interest to Plant Pathologists............Members of the Society

THE PRESENT STATUS OF PLANT PATHOLOGY IN AGRICULTURE

By Professor H. H. Whetzel, Cornell University.

Mr. President:

I am not accustomed to this kind of introduction in New York, the state where I have lived so long, and naturally I appreciate the good things the Chairman has said and the kind welcome Dr. Harrison has given us. I am sure Cornell has very kindly feelings for her Canadian students. We have had a large number of them. A Canadian, Dr. Schurman, who has just recently retired, guided the destinies of the University for a good many years.

When I promised to come down to talk to you, I said to my friend, Professor Dickson, that I would not agree to prepare a paper, so I can only say that you will not get an address, but merely a talk. I have been called upon to prepare so many papers this year, that I have rebelled and will not write any more.

My subject naturally interests me. A man ought to be interested in his profession, and not only interested in it, but he should "boost" it. If he is not in that frame of mind, he is in an unfortunate position for the profession and he is out of place.

I shall indicate briefly what I believe to be the position of plant pathology at the present time in agriculture, and shall also suggest, if I may, my ideas as to the future of plant pathology in agriculture, because if a man has no vision, he cannot be very much in love with his profession.

In the first place, I should like to touch on the historical side of plant pathology and briefly outline some of the important features as far as they relate to this talk. Modern plant pathology—I am not going back to the time of the Romans—began approximately in the middle of the 19th Century. American plant pathology began about 1883—or say 1880. The history of plant pathology on this continent is, in many ways, detached from the history of plant pathology in Europe. To be sure we drew our inspiration and to some extent our general outlook from those who there laid down the first principles, but American plant pathology has been characteristically American.

American plant pathology may be divided into two rather distinct periods. From 1883 until 1906 we had very rapid developments in the science along two lines. In the first place when the early plant pathologists began to investigate, they found before them a great variety of diseases. They attacked those nearest at hand and whatever they did yielded new facts, new information, because

it was the pioneer period. The diseases were often different from those in Europe or manifested themselves more destructively. The introduction of imported plants from Europe, the distribution of the agricultural flora, etc., all combined to make America an interesting field for plant pathologists.

Another feature affecting the point of view is that these men were trained as mycologists—they had come under the influence of De Bary and others and so followed along those lines in this country. Those men in Europe wrestled with problems of plant diseases to be sure, but particularly the mycological phase of the problems. One—Millardet—in France, experimenting in plant disease control, discovered Bordeaux mixture, and this was the beginning of the economic development in plant pathology.

This discovery is of interest because it led to the second line of development of plant pathology in America. America came very early into contact with Bordeaux mixture. Shortly after the outbreak of the grape mildew in Europe, there came to the United States Department of Agriculture at Washington, a French pathologist to study the disease over here, and it happened that the Department had at that time a number of young men who had begun to interest themselves in mycology. The cultivated vine in this country had also been attacked and these men began experimental work with Bordeaux mixture. This was the beginning of economic plant pathology on this continent.

The economic side was stressed from 1883 to 1906, and the study of plant pathology was taken up by mycologists who gradually became known as pathologists. Even at the present time very few men have been trained as plant pathologists. I was trained as a mycologist. It is true that in Experiment Stations they were given the title of "plant pathologist", but they were, for the most part, mycologists. The trouble was that plant pathology was not recognized then as a definite science. There was no chair of plant pathology in any university in the States. There was, however, a chair of plant pathology in Asia—in a Japanese University, about a year before the one at Cornell was established. Plant pathology was taught in courses, but an examination of any of these courses would make it evident that it was a course in mycology, so that the development of our science in most of our universities was strongly mycological, necessarily so because of the training of the men who worked in this field. It will be a generation yet before the men who determine the trend of plant pathology will be real plant pathologists. The thing that determines whether a man is a plant pathologist or not is his *point of view*. A man may work out the control of diseases in plants and still not be a plant pathologist.

Plant pathology is not a fundamental science. I am not sure that it is a science—among friends, I can admit that there are two sides to the question—but it is perfectly true that plant pathology is built upon other sciences. It is an

applied science. It has not come to be an art yet ! Chemistry, botany, physiology, histology, cytology and bacteriology are all fundamental to it and we require our graduate students to study them, as a good knowledge of these fundamentals is necessary for the practice of plant pathology. Plant pathology, therefore, is an economic or an applied science, and this puts us in the position to consider its relations to the subject of agriculture.

The history of college instruction in agriculture is very interesting. I want to point out to you the divisions into which agriculture was divided when it first came into our colleges, namely, chemistry, botany, animal husbandry, etc., and also that most directors of agricultural colleges were at first chemists, for chemistry was at first one of the most important divisions in our colleges of agriculture. Then we began to have departments such as agronomy or fieldcrops, horticulture, floriculture, pomology, etc. The evident trend now is to go back and recombine departments along the old fundamental science lines.

Plant pathology is generally looked upon in most agricultural colleges today as a division of botany. Perhaps it was best at first to have plant pathology a part of the general department of botany, but the conditions under which the work developed at Cornell were not such as favored keeping it in the department of botany. In the College of Agriculture at Cornell the department of plant pathology was a development from that of botany in the University. It was at Cornell that plant pathology had its first separate chair in an American University.

Now perhaps I can best illustrate the position of plant pathology in agriculture by using my own state as an illustration. You will pardon me for bringing my own experience in by way of illustration, but naturally no one else has developed plant pathology as I think it ought to be, and naturally I have to use my own State !

It seemed to me from the beginning of my work that since plant pathology is an applied science—an economic science—that it must "deliver goods" of that kind : that it must serve the economic field, and naturally that field is the agriculture of the state or nation, and those lines directly associated therewith It has generally been held to be true that the first obligation of a plant pathologist of a college was to the farmers and nobody else. I never could quite subscribe to that narrow view. The plant pathologist of the state should serve any citizen of that state who had a phytopathological problem to solve on his land, garden, front yard or even manufacturing establishment. All citizens pay taxes and, therefore, all men who have plant pathological problems have a call on his services. So that in developing plant pathology in a college of agriculture, the service should be carried to all who may legitimately claim it.

When I came to Cornell University one could buy stock in plant pathology for almost nothing. To illustrate, on one occasion I had to address a company of farmers on a pathological subject, along with a leader of the Farmers' Institute, and I got from him scant encouragement. I took for my subject "Fire Blight", and as I was young and enthusiastic, I carried with me considerable impedimenta, such as a lantern, slides, and a microscope. When I timidly suggested to the leader that I should have a place where I could exhibit my wares, I was told that the farmers would not understand me. (This was in 1903 when I was assistant in botany.) However, I secured a table where I set up my microscope and I was very much encouraged to find that the farmers did respond to the things in which I was interested.

I desire now to give you some notion of how plant pathology has "sold" itself in the State of New York. In 1906, when I was made assistant professor and head of the department, I had one assistant, a stenographer and $300 for all overhead expenses. At that time all field work and travel done by the departments at Cornell was paid for from appropriations given by the state or federal government. It always hurt when I had to spend money out of my grant to go and visit a sick geranium. I could not keep within the allotted appropriation and do all the work there was to be done. Gradually my work developed and was carried into the fields and orchards. I simply had to have more money to meet the demands for research and extension work. Then I got a little encouragement from my director. I suggested that the growers be asked to pay expenses for requested visits to inspect their fields and orchards. He was always lenient with my wild ideas and gave his consent for me to try this. The response from the growers was prompt and encouraging.

In 1909 we became interested in lime sulphur as a summer spray. We had in the department a young man from Nova Scotia who was interested in apple scab. Wallace became interested in lime sulphur and did some preliminary experiments in orchards near Ithaca. I had no money to keep him and I saw that we were going to lose him. A manufacturer of lime sulphur finally offered money for continuing the work. After considerable effort I managed to put this proposition through. I suggested that as it was an economic problem, we should ask those who benefited to bear a portion of the expense. I went to my director and he said he thought it was a good scheme, but it was radical, and he asked me if I did not think I would get into trouble. However, he laid it before the Board of Trustees and I got my first Industrial Fellowship. A field labortory was established—a laboratory in a grower's orchard. The grower furnished trees to work upon. If we destroyed a lot of apples, the grower could not claim compensation from the university. In other words the grower was willing to back our investigation. The Industrial Fellowship policy was established.

It is instructive to note where the objections came from against thus selling plant pathology to people. They did not come from the farmers, they came from my own colleagues in Cornell and other institutions. They said I would lose my job, but as yet I have n't. The point I want to make is that up to 1907-8 research in plant pathology in the average institution was generally pursued on the College or Experiment Station farm. If the pathologist went elsewhere then the grower was to be reimbursed, so to say, for allowing the plant pathologist to solve his problems. It was like a doctor paying a patient for allowing him to operate on him. In 1909 we had our first industrial fellowship, which brought to the Institution $1,000. Since 1909 we have had approximately $80,000 in fellowships. Last year we had about $20,000 for this purpose from the growers and commercial concerns of the State of New York. I think that plant pathology as an economic science— as a profession—will sell itself. It ought to return interest on the money invested in it.

This change in the attitude of New York State is rather remarkable, especially if you know the New York farmer, for he does not spend his money without thinking carefully. To have this happen in a conservative state seems to me exceptionally good proof that plant pathology does have a place in economic agriculture.

The development of plant pathology in America has been very rapid since the year 1906, but a different kind of development from that prior to 1906. The development of plant pathology as a profession in the universities beginning with the establishment of the first chair of plant pathology at Cornell University, is an acknowledgment of the fact that the science of plant pathology is a phase of agricultural education and the result has been very promising. The rise and development of the Phytopathological Society on this continent is good evidence that this science is a part of agriculture.

For a long time the entomologists had the stage and the plant pathologists were lost among the botanists. I think it is safe to say that the plant pathologists of the United States and Canada constitute now as well-recognized a group of scientific men as there is anywhere. I think that they are better known to each other. They meet together more frequently than some other groups and that in spite of the fact that the organization is very young.

What is the justification for this rise and development of plant pathology ? I think justification is found in the fact that the diseases of plants play an important role in crop production. The best evidence of this are the serious losses from plant diseases which occur every year. In ordering sweet potatoes for example—for every two sweet potatoes that are delivered on your table, one other has been lost to disease. For every six cotton shirts that you buy, one has been lost by disease in the cotton fields of the south. The losses from plant

diseases on this continent run into millions of dollars annually. This loss is an economic waste that does no one any good. The results of this loss mean the cultivation of more acres of land by the individual farmer to get the necessary returns. The consumer pays for many more potatoes, or shirts than he wants. The small amount of money that the middle man filches is paltry compared with what fungus diseases take out of the crops of the country. One great reason why plant pathology has come to be recognized is because of the tremendous losses which occur and the reduction in those losses which the development of plant pathology has been able to show. Plant pathology is one of the most important phases of agriculture, and it, with entomology, can probably give larger returns on money invested in it than any other line of agriculture.

What then is to be the future development of plant pathology ? Its study should not be confined to agriculture colleges. The tendency in large universities is to put it in with some other department, such as botany. Even the Rockefeller Institute has considered the development of a division of plant pathology. The importance of the science has come to be recognized and we are going to be flattered in the future. I am not thinking of the development in colleges and universities.

New York farmers are also paying this year $20,000 for the extension work of the plant pathologist and entomologist. It works out in this way. When, for instance, a group of apple growers want a special spray service, they go to the Farm Bureau Agent and tell him they want an expert to give them advice and look after the work for them during the growing season. The College has a standing offer to supply these men. These men are seniors or first year graduate students. Their salaries run about $150 per month, of which the college pays $50. They are picked men of the institution and are sent into the county as representatives of the departments of plant pathology and entomology. The farmers prefer to go to Cornell for their plant pathologists and that institution had twelve operating in the state last season. The farmers provide, in addition to $100 for salary each month, a Ford and pay for its maintenance. It is generally a six months' proposition, for they live among the farmers while giving their services. To help in this work the Weather Bureau makes special forecasts of the weather for us in certain sections.

It is interesting to note that these men who go to the farmers are not experienced men, but they are picked men of ability. After a special training of two weeks they go into the field. They have to make good with the farmers and they have to make good with us, and if they fail they cannot stay for graduate work. We sometimes have failures, but not many. Farmers are willing to pay as high as $200 a month to a good man who has had a year in the field.

I think we have demonstrated clearly that plant pathology can be "sold" to farmers in much the same way as veterinary services can be sold. We can do far more in extension work with the money that the growers put in than we can with State dollars alone. It is perfectly certain, I think, that should the State not give any money for the work, the growers would raise the necessary cash.

During the war, when so many students were away, the trouble was that we could not get enough men in order to spend money we had at our disposal. However, since then, the State of New York is getting many men, who have returned from the war, for this extension work : in other words, it is getting the best brains of the country at a time when the men are most vigorous and most willing to work—it is getting extra good service at a time when young men will work the hardest.

The State cannot continue to appropriate increasingly large sums, nor should the State spend more than a limited sum of money, in order to give service to the farmers. But you can *sell* to the farmers in the State of New York what you could not possibly *give* them. While most of the population of the State of New York lives in cities, yet the State treats agriculture very well indeed. It supports other agricultural schools as well.

A large number of fruit growers, packing houses and potato growers will in the future maintain plant pathologists. Already a large seed company in New York has taken on one of our young pathologists. "If you will come with us, they said, we will pay you a salary to keep our stock clean and pure but only on condition that you go to Cornell in the winter and get your Doctor's Degree. You spend the summer on our stock and the winter at Cornell. When you get your degree, we will make you a permanent place in our staff as our plant pathologist."

I have tried to give you very briefly my idea of the place of the plant pathologist in agriculture, and I thank you for your interest and attention.

OUR WINGED ALLIES

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Man has elected himself lord of creation, but quite frequently he is reminded that the vote was not unanimous. Several very considerable groups of animals show by convincing actions that they have no respect for man's claim, and that he must frequently demonstrate his power both to take and to keep what he desires of earth's products. The other forms of life which, with ourselves, are directly or indirectly parasitic on the plant world, may be arranged in ascending order in the form of a tree. The upper parts may or may not have arisen from the lower portions, but at any rate the arrangement indicates a gradually but not uniformly increasing complexity of structure, and advance in intelligence. But instinct, that mysterious half sister of intelligence, makes formidable the lower groups, and whether we consider it the inherited memories of the race, or specially implanted knowledge, it is an effectual substitute for both intelligence and education.

At the base of our tree of classification are the Protozoa, the simplest of animals, showing some 4,000 kinds of one celled creatures. Above them are the colonial forms such as the Sponges, about 700 kinds. Near and probably related are the Flatworms, 1700 kinds, and the Coelenterates, 3,000 kinds, of which several produce corals. Above these but showing some relationship in their radiate symmetry are the Starfish and Sea Urchins 3,000 species, and the Rotifers and Segmented Worms, 2000 species. Here we reach creatures having bilateral symmetry,—the Mollusks, 25,000 sorts of them, and the Crustaceans, about 6,000 kinds. On the same great branch above the Crustaceans are two groups, the Spiders containing perhaps 4,000 species, and the other, the most formidable order of animal life, the Insects, of which about 250,000 kinds are known, and this is believed to be not more than one fourth of the species now existing. Not alone in number of kinds but in numbers of individuals of each kind, is this the most threatening of contestants for the fruits of the earth. On another stem of our tree of life are the back-boned creatures, Fishes 13,000 kinds, Amphibians 700 kinds, Reptiles 3,000 kinds, Birds 10,000 kinds, and Mammals 3,500 kinds.

Among the different classes named, man needs to recognize his friends and his enemies. All will obey nature's prime law, and will struggle for an existence and in doing so will destroy more or less of the available food in the world. Which of these groups will be direct rivals of mankind, seeking the food which man himself requires, and on which of them can man depend for aid against these rivals, by attacking, killing and eating them? Of all the invertebrate groups we find only one which seems to threaten seriously man's rule and welfare. The

insects—by their wonderful physical adaptation to their surroundings, by their ability to reproduce themselves at enormous rates, by their prodigious appetites, and their power of withstanding, in some form, extremely wide ranges of temperature,— show themselves to be man's formidable rivals for the possession of the earth. It has become a commonplace to be able to destroy by a few shots, a great ship which is so far away as to be almost invisible, but man's victories,— even his partial victories,—over insect attacks, may be counted on the fingers of one hand.

One invertebrate group, the Spiders, stands as man's ally against the insects, and,—while as yet scarcely recognized as a friend,—works early and late in building and rebuilding its snares for the common enemy. The other invertebrates are of no economic importance, except the Mollusks and Crustaceans, which are eaten by man and those others which furnish food for fishes. The vertebrates may largely be accounted as allies,—the fish destroying enormous numbers of insect larvæ ; amphibians and reptiles, living almost entirely on adult forms ; while in the birds we recognize our very best friends, especially qualified to give us both gratification to eye and ear, and much needed assistance in restraining the swarming millions of insects. If the inactive toad or frog is worth two dollars per year to the gardener, what indemnity shall we fix for the nuthatch, creeper, and vireo searching our trees from roots to branch tip for eggs, larvæ, or winged insect, or the swallow and martin sweeping the galleries of the air and appearing at the nest every ten minutes with a new captive !

By glancing over the different groups of birds we may reach a better conception of the gratitude we should feel for these our allies, and the support and encouragement we should give them. In arranging birds in groups which show their relationships, we begin with those which make their homes and find food and safety in, or almost in, the water. The first group is that of the Pygopodes or Divers including Grebes, Loons and Auks. These are all fish eaters, although no doubt Grebes eat numbers of insects and larvæ in the fishless ponds in which they often raise their broods.

The second order of birds is that known as Longipennes or Longwinged Swimmers including the Gulls, and Terns. Many of these are insect eaters, especially Franklin's Gull which feeds on the worms, grubs and grasshopper enemies of our prairie farmers. The Black Tern also deserves its name of Sea Swallow from its habit of hawking over our marshes, and living to some extent on insect food. The Tubinares are haunters of the deep seas, tireless fliers and probably of no economic value. The Fulmars, Shearwaters and Petrels belong to the waters off our Atlantic Coast. The next order—the Steganopodes—includes the swimmers which have all four toes united by webs. These are the Gannets, Cormorants and Pelicans. All of these are fish eaters and some of them have been accused of injuring the salmon fisheries, but intelligent study

of the matter proves them to be beneficient through their destruction of worthless fish, and quite harmless under all ordinary circumstances.

The order Anseres includes what are commonly called the Waterfowls, and we must acknowledge our past and present debt to the Swans, Ducks and Geese as direct providers of food. A few of the ducks eat small fish and shell fish, but the enormous numbers of insects they destroy, especially in the larval stage, place them among our benefactors from this point of view also.

The deep water waders are called Herodiones, and include as common Canadian birds only the Herons and Bitterns. Bitterns are poor fliers and find safety by standing silently with mottled yellowish and brownish body, neck, head and long sharp bill quite erect. Among the reeds and cattails a sharp eye is required to distinguish this stick-like structure from the similar objects about. The bittern's food is frogs, snakes and fish, but certainly none of value. The Blue and the Green Herons also live on fish, batrachians and insects found in shallow open water.

The next order, Paludicolæ, comprise the birds which walk over the soft marsh borders of lakes, and ponds. Cranes are long as to toes, legs, necks and bills, while the Rails and Galinules, have long toes but very moderate legs and necks. Their food consists chiefly of the insects found about marshes, along with wild rice and other vegetable matter. The Sandhill Cranes quite frequently visit grain fields after harvest, and with the Rails are counted as game birds.

The Shore Birds, Limicolæ, have long been a favorite group with sportsmen, both for the pleasure afforded in hunting them and the very delicate flesh which they furnish. Their destruction has been extremely rapid in most species, because each new generation, coming south from their wilderness hatcheries, often within the arctic circle, learns wisdom only when their dense flocks have been decimated by the breechloader. These plovers, snipe, and woodcock live apparently on soft bodied worms and insect larvæ, found in or on the soil of waste lands and the margins of lakes and oceans. They are certainly harmless and may well be considered beneficial.

We now come to birds which make their homes, obtain their food, and raise their young with slight reference to bodies of water. The Gallinæ, or Earth Scrathers, are entirely land birds, unable to swim, and they get their food—insects and seeds—entirely from the soil. Our poultry yard is stocked with tamed *Gallus bankiva*, descendants of the red jungle fowl of India, and with turkeys of the species which ran wild in Texas and Mexico. To the farmer these birds are of great importance since their food consists of seeds, fruit and insects. Fortunately weed seeds and waste grain form the great bulk of their vegetable ration, while some of them, particularly the quail and turkey, feed largely upon

injurious insects. The Bob-white feeds freely of the potato beetle, wire worms, and cut worms, while hundreds of grasshoppers are consumed per hour as a flock of young turkeys traverse a meadow or pasture.

The next group is that called Raptores, including eagles, hawks, owls and vultures. Many other kinds of birds are rapacious, but no other are so well equipped for capturing and killing other birds as well as small animals, and even fish. In spite of their highly specialized beaks and claws, our Canadian hawks, with very few exceptions, are mild and beneficial birds, only one of our owls is persistently injurious, while in no part of our country are eagles or vultures a menace. The hawks known as the Sharpskin and Coopers or the Duck hawk and Pigeon hawk, are destructive of valuable insectivorous birds, while the Gyrfalcon kills large numbers of the grouse of the northern wilderness. The Great Horned Owl visits and revisits the poultry yard, carrying away even turkeys and geese, and, if these are not available, attacking any of the other birds of our woodlands. All the other hawks and owls live upon the vermin which are such pests to agriculturists. Mice, rats, moles, grasshoppers, beetles, crickets, spiders and frogs are their usual bill of fare, and in the capture of these they are very persevering and skillful. The false idea, born of ignorance, that the killing of hawks and owls is meritorious is an anachronism, and should be banished to that limbo which has finally received, we hope, the hunting of the wren, and other such cruel superstitions.

The Coccyges is a group in which are birds showing but few similarities,—the cuckoos and the kingfishers. The cuckoos are heard more frequently than seen, being fond of dense thickets of shrubs, from which their call is heard in the late springtime. They live upon insects, and deserve our protection because of their unusual courage in eating largely of hairy caterpillars, especially those which defoliate our trees. European cuckoos are parasites, dropping their unwelcome eggs into the nests of small birds, Canadian cuckoos seldom do this, but build their own nest and rear their young in the orthodox manner. The Kingfishers live on small fish, but do little harm except possible in streams planted with troutlings. Their food is mostly the coarse and useless minnows and perch which would certainly feed on the eggs of better fish.

The order Pici includes our carpenter birds the woodpeckers. Ignorance, and the hereditary barbarism which prompts us to kill, have made these birds the targets for that destructive combination—a boy with a gun. We now know that, with one exception, the woodpeckers are interested in a tree, only that they may relieve it of its insect parasites. The exception is the Sapsucker, which punctures the protecting cork covering of several kinds of trees, and leaves them open to fungus infection, after it has eaten away the cortex and cambium which in the spring are filled with sugar or starch. The perforations may form a girdle about the trunk, and quite often result in the death of a valuable tree.

The Yellowhammer or Flicker has taken to the ground and lives largely in the contents of anthills. The wooden homes of the woodpeckers are frequently accepted by other birds, after one season of occupancy by the builders. Bluebirds, swallows, flycatchers, and the small owls show their respect for the ability of the avian architects, and suggest to us their desire for a shelter which we may easily provide for them.

The order Macrochires have, as the name indicates, wings that are large in proportion to the weight of the body. The Nighthawks and Whip-poor-wills, the Chimney Swifts, and the Hummingbirds make up a group showing little similarity. The first two are known as goatsuckers, probably from their wide mouths, and habit of haunting pasturefields in the twilight. Their food, like that of all the other members of the group, is the insect life they capture while on the wing. The Hummingbirds take also the nectar of flowers along with their small insect visitors.

We now come to the last and largest order of birds, the Passeres or Perching Birds, containing nearly as many kinds as all the other orders together, and among them those best known and most important to man. Nearly all have calls for their mates and companions, and many produce distinctly musical songs, repeated at long or at short intervals. The Flycatchers differ from other insect eaters in their habit of watching for their prey and darting upon it from a prominent perch, to which they usually return again and again. Their food is commonly captured near the ground while flying, but wingless forms are not despised. These eminently useful birds are known to us as Phoebes, Peewees, Kingbirds, and such Flycatchers as the Crested, the Scissortailed, the Olivesided and several others. Some build their homes about houses and bridges, others in small trees in open fields, while others prefer the depths of the forest. Moths, caterpillars, ants, wasps, flies, crickets and grasshoppers make up their common bill of fare.

In Canada we have only one species of Lark, although it varies in shade and size. Those found in the forested districts of the east are large and dark, with strong plumage markings, while the prairie varieties are smaller and paler. The Horned Lark is about one half larger than the house sparrow, with grayish upper plumage, yellow throat with a black spot across the breast and a black horn-like tuft above each eye. It has a slight but sweet song in early spring, and is a valuable destroyer of weed seeds in the open fields from which the snow is disappearing.

The Crow Family plays important parts in almost all parts of the world and are prominent and well known birds. It includes the Raven, Crow, Magpie, and Jays in Canada. Ravens are plentiful near fishing villages in Western Nova Scotia, but avoid all evidences of civilization in the interior of the contin-

ent, retreating before the lumberman and prospector. The crows on the contarry thrive in agricultural districts. Magpies belong to the western plains while jays inhabit forested regions. All the family are fond of animal food. Ravens attack weak or sickly lambs and live largely on living or dead crabs, lobsters, and fish that may be exposed at low tide. Crows haunt the edge of the water for any kind of animal refuse, searching also the nests of smaller birds for eggs or young, and destroying in late summer enormous numbers of insects, grubs, mice and small reptiles. But they are practically omnivorous, and are hated by farmers because of their vicious habit of pulling up and eating the sprouting grains, and also opening and eating the ripening ears of maize. Jays live largely on acorns and beech nuts, but also take eggs and young birds from the nests, and in winter will steal any kind of grain, especially maize. It is as yet impossible to say on which side of our account with this family the debit lies, and it quite certainly varies with the district and the season. Their intelligence will prevent their suffering any loss which might excite alarm.

Our groups of Blackbirds, which also includes the clear voiced oriole, and the so-called meadow lark, comprise at least two distinctly harmful species. These are the bronze grackle which destroys the young of many musical and insectivorous birds, and the cowbird, which is entirely parasitic in the matter of rearing its young. By dropping its egg into the nest of some smaller bird, the cowbird usually secures for each of its offspring the entire industry of a pair of foster parents. The young cowbird, by its precocity, absorbs nearly all the food brought to the nest and soon pushes overboard the legitimate nestlings, which are thus all sacrificed for the sake of the one intruder. By a surprisingly acute instinct, the young cowbird deserts its misguided foster parents, and joins with the flocks of its own kind before the autumn migration. The red shouldered starling, the bobolink, the oriole and the meadow lark are favorites with all, destroying our plant and insect enemies and providing joyous bird music.

The Sparrow family includes the Grosbeaks, Snow Buntings, Finches, Crossbills, Redpolls, Siskins and Longspurs as well as Goldfinches and Sparrows, All have strong and mostly conical bills, that of the grosbeaks being clumsily large, while the tips are curved and crossed in the crossbills. They are all seed eaters, but feed their young nestlings with insects. All of the list, except goldfinches and sparrows, come to southern Ontario only as visitors during winter and spring and gather the seeds and fruits left uncovered by the snow. Many are bright colored, and a few,such as the Rosebreasted Grosbeak and the Purple Finch, have very pleasing songs. Excepting that illmannered immigrant—the house sparrow—the whole family is worthy of our protection and encouragement. The pine and the cardinal grosbeaks of the above group, and the scarlet tanager are among our most notable examples of seasonal plumage chan-

ges. The adult males in spring are brilliant in suits of red, which gradually change during summer to match the greenish yellows and browns of the female. The latter may well be considered as wearing a protective coloration, when we consider how seldom we see or recognize the females as compared with our familiarity with the males.

The family of Swallows should have our very special care. They eat nothing of value to man, but destroy enormous quantities of insects caught on the wing over pastures grainfields, ponds and farm yards. With a little encouragement they will form colonies about farm buildings. The purple martin takes very kindly to birdhouses placed on tall poles or on buildings, and their graceful flight and pleasant gurgling notes are among the most satisfactory associations of summer in town or country.

Waxwings wear perfectly fitting suits of quaker brown, but their well marked crests and alert attitudes, and particularly the white wing marks and the garrulity of the erratic Bohemian waxwing neutralize any suggestion of passivity. A small fraction of their food may be cultivated fruits, but by far the greater part consists of harmful insects and waste wild fruits. The Shrikes destroy some desirable small birds but this may be balanced by their attacks on mice, crickets and grasshoppers in summer and house sparrows in winter. Vireos or Greenlets are small greenish brown birds which live almost entirely on the insects which infest our trees, particularly the slender branches and leaves. Some of these inconspicuous friends of man may be heard singing almost continuously throughout the brightest and warmest hours of midday.

The Wood Warblers are in general small in size and wear brightly marked plumage. They are unknown to the ordinary unobservant person, but are worthy objects of delightful woodland walks to those initiated into the charms of bird study. An opera glass is required to make clear their markings and when the warblers can be recognized and named without a gun, the fortunate person may consider himself an amateur naturalist. They are all insect eaters, inhabiting groves and the higher parts of trees.

The most notable of our Canadian singing birds are the catbird and the brown thrasher. The former is smoky gray in color and usually sings from the shelter of a thicket. Its relation to the mockingbird is shown in its power of mimicry by which the songs of other birds are reproduced in clear melodious and continued strains. The thrasher sings usually from a prominent spray or the top of a small tree and its song rivals that of the catbird. Both of these birds live largely upon injurious insects and wild fruits,occasionally visiting the cultivated raspberries. Wrens require no description or introduction because their busy singing, scolding, insect catching lives are so often closely associated with our houses, outbuildings, and orchards. A box, tin can or broken flowerpot

may be made the centre of amusing and beneficial activity as well as most cheerful music if we will locate it in a reasonably secluded but accessible place. The marshwrens build many globular nests among the cattails, and sing delightfully as they rise in short flights. Nuthatches and chickadees are seen in southern Canada mostly in the late fall and winter, the former searching the trunks of trees, the latter the smaller branches, for insects or their eggs or cocoons.

Canadian thrushes are, with a few notable exceptions, shy birds of deep thickets, or evergreen forests, from which their ringing but liquid notes may be heard at sunset. Our robin and bluebird are the members of the family which have shown a decided preference for the vicinity of man's buildings and orchards. Here they gratify his eye and ear from early spring until forced by cold and hunger to migrate southward. The robin may become a nuisance where small fruits are raised for market, but almost all its annual activity is for the benefit and pleasure of its human neighbors, in whom it has such confidence. Nearly one half its food is known to be of insects and worms, and except for a few weeks the remainderis of wild fruits. Few of us can show so excellent a life record as these cheerful and tuneful allies.

ADDRESS BY Mr. A. GIBSON, DOMINION ENTOMOLOGIST

Mr. Gibson gave a sketch of the various branch laboratories at Annapolis Royal, N. S., Fredericton, N. B., Hemmingford, Que., Vineland, Ont., Friesbank, Man., Saskatoon, Sask., Lethbridge, Alta., and Agassiz, B.C., and described the nature of the work carried on. He also sketched the work done in connection with Forest Insects and the European Corn Borer.

The address was illustrated fully by means of lantern slides.

THE LARCH APHIS

By Dr. J. C. Chapais, St. Denis, Kamouraska

About the middle of June, 1920, while I was making my Spring inspection of the trees of my arboretum, which contains a few fine specimens of the American Larch (*Larix Americana*) (vulgo : *Epinette Rouge, Tamarack*), I thought that the new Spring growth of one of them had a strange appearance and, on looking at it more attentively, I found that part of the tips of the new twigs were loaded with a mixture of sticky honey-dew, of numerous specimens of large dark aphides provided with very long legs, and of quite a host of very lively tiny black ants. In this mixture the new Spring needles or leaves of the twigs looked rather sickly. I was, evidently, in the presence of a new insect, uterly unknown to me.

As I usually do in such circumstances, I decided to send a few specimens of the twigs bearing this mixture to Mr. W. Lochhead, Professor of Biology at Macdonald College, to get from him some information concerning this new and very strange looking visitor to my larches. As usual, Mr. Lochhead very willingly sent me his answer, which was that I had to deal with a larch aphis very probably *Lachnus laricifex*, Fitch, and that I would get more information on this subject if I could get hold of a bulletin of the Orono, Maine, Agricultural Experiment Station, entitled : "Bulletin 202—July—Aphid Pests of Maine : Food Plants of the Aphides ; Psyllid Notes." Following Mr. Lochhead's advice, I got the above mentioned Bulletin, written by Dr. Edith M. Patch, from which I have extracted the following information concerning what is, very probably, *Lachnus laricifex*.

In this Bulletin, Miss Patch, one of the best United States authorities on the Aphididæ family, gives some notes on various species of Aphides, one species found on ferns, ten species on conifers, besides six species of the genus Lachnus, a sub-family of Aphididæ amongst which was mentioned one which seems, very likely, to be the species found on one of my own larches. Miss Patch has this to say about it :

"*Lachnus laricifex*, Fitch. What is apparently this species of Fitch is not uncommon on the larch (*L. laticina*, Koch) in Maine. Packard (1890) quotes the original description, and records scattered individuals from Augusta, Maine. No figures have been published for this larch aphis in America.

Cholodkovsky (1899), however, figures a larch species, *maculosus* Cholodkovsky, which is certainly closely allied to the Maine material and may perhaps be the same.

"I have no authority for calling this species *laricifex*, except that there is nothing in the description of Fitch or others to preclude its identity with that species, and the habitat and what habits are recorded for *laricifex* agree with this Maine species. There is, so far as I know, no authentic specimen of *laricifex* for comparison."

I append here a short explanatory note concerning the genus *Lachnus* above mentioned :

"This is a large and wide-spread genus of Aphides or plant-lice, typical of the sub-family *Lachninæ*. They are characterized by the linear stigma and nearly straight fourth vein of the fore wings. Nearly all the many species have woolly-looking waxy exudation, whence the name."

I intend, if I find this aphis on my larches next summer, to send a few specimens of it to Dr. Patch for identification and comparison with the species that she has found on the Maine larches.

If I am right in my identification of what I am inclined to call my new entomological find, it would be classified as follows : CLASS, Insecta ; ORDER, Hemiptera ; SUB-ORDER, Homoptera ; FAMILY, Aphididae ; SUB-FAMILY, Lachninae ; GENUS, Lachnus ; SPECIES, Lachnus laricifex, Fitch.

CHEMICAL INVESTIGATION OF SPRAYS

A. Kelsall

Most of our knowledge on the efficiency and action of insecticides and fungicides has been derived from actual field observations. That is to say, many materials have been tried and their action upon plant pests noted, and their action upon plant foliage noted. Following such methods there has, during the past many years, accumulated a vast amount of information on the use of many materials as insecticides and fungicides. The reason why certain materials act as they do is often imperfectly understood. Much light has, however, been thrown on this by the chemical investigations of numerous experimenters. In France and England the chemistry of Bordeaux mixture has been thoroughly studied, and much of our knowledge of insecticide arsenicals we owe to the chemists of the U. S. Insecticide and Fungicide Board. The greatest bulk of materials used in plant pest suppression, consists of compounds of arsenic, of copper, of sulphur and of nicotine. In this brief address, I will just touch on some of the salient points of these arsenic, copper and sulphur compounds, presenting some information which has been long known and some of more recent origin.

Commencing with arsenical insecticides, it may be stated that an arsenical to be an efficient insecticide for application to foliage, must possess the following qualifications :

1. It must be soluble in the digestive juices of the insect, otherwise it will not kill.

2. It must, as nearly as possible, be insoluble in water, or it will injure the foliage.

The insecticide which best fulfills these conditions is lead arsenate.

Lead Arsenate

Lead arsenates have, in the past, been placed upon the market in three forms, or generally as some mixture of three forms.
These consist of the compounds :

$Pb\,H\,As0_4$ di-lead arsenate.
$Pb_3\,(As0_4)_2$ tri-lead arsenate.
$Pb_4\,(PbOH)\,(As0_4)_3$ basic lead arsenate.

Of these three, all are satisfactory insecticides, but the latter two, owing to the smaller amount of arsenic they contain and to their more expensive nature, have been largely discarded, and manufacturers aim to produce the com-

pound $PbHAsO_4$. This compound is generally highly satisfactory and non-injurious to foliage. But there are some cases where foliage injuries, sometimes very serious, result. The explanation of these is to be found in the presence of impurities in the water used. Di-lead arsenate in pure water decomposes in the manner shown in the following equation :

$$3PbHAsO_4 = Pb_3(AsO_4)_2 + H_3AsO_4.$$

That is, there is a certain concentration of free arsenic acid, but this concentration in pure cold water does not exceed a few milligrams per litre of water, an amount entirely negligible.

If some impurities are in the water, the amount of water soluble arsenic may be increased tremendously. Thus ordinary calcium carbonate reacts in a manner which may be indicated in the following equation :

$$5\,PbHAsO_4 + 2CaCO_3 = Pb_4(PbOH)(AsO_4)_3 + 2CaHAsO_4 + 2CO_2 + H_2O.$$

The di-calcium arsenate thus produced is fairly soluble in water. This reaction may even be produced from the calcium carbonate adhering to the sides of a spray tank which has at some time contained lime.

If common salt is contained in the water a reaction follows which may be represented as follows :

$$5PbHAsO_4 + NaCl = Pb_4(PbCl)(AsO_4)_3 + NaH_2AsO_4 + H_3AsO_4.$$

Here again, large amounts of water soluble arsenic are liberated. Similar reactions occur with other water impurities, and consequently where $PbHAsO_4$ is used on tender foliage (I am speaking of its use unmixed with any fungicide) a fairly pure water is necessary. With impure waters the basic lead arsenate is much preferable, and this has been recognized for many years.

It is also very noteworthy that while $PbHAsO_4$ is unreacted upon by the carbon dioxide of the air, mixtures of $PbHAsO_4$ and lime are reacted upon precisely to the same extent as is calcium arsenate. It follows, therefore, that it is unnecessary to use the expensive $PbHAsO_4$ in mixtures containing excesses of lime, for calcium arsenate fulfills the same purpose.

Calcium arsenate

The exact composition of commercial calcium arsenate is not known. Several calcium arsenates are known, most notably di-calcium arsenate $CaHAsO_4$ and Tri-calcium arsenate $Ca_3(AsO_4)_2$. Both these compounds are too soluble for spraying purposes. The commercial compound contains a higher proportion of calcium and is very insoluble,

As you all know, calcium arsenate can only be used on foliage which is fairly resistant to arsenic injury. Calcium arsenate, though very insoluble in water, is unfortunately reacted upon by carbon dioxide. Consequently, when exposed to the air a certain amount of soluble arsenic is produced, the reaction being of the following nature :

$$Ca_3(As0_4)\ 2 + C0_2 + H_20 = 2CaHAs0_4 + CaC0_3.$$

That is to say, the more basic insoluble calcium salts are converted into the mo re soluble hydrogen salts. Naturally, in the presence of an excess of free lime the above reaction cannot occur, so that calcium arsenate is satisfactory in such mixtures which contain an excess of free lime.

White arsenic

White Arsenic As_20_3, is too soluble to permit its use on foliage. Mixed with lime, it forms calcium arsenite, $Ca(As0_2)_2$, and this also, though a relatively insoluble salt is so readily decomposed that it is highly injurious to foliage. When added to Bordeaux mixture, however, white arsenic loses, under certain conditions, its injurious properties. The arsenic ceases to be soluble in water. Whether this is due entirely to chemical union or to absorption by the copper precipitate is not altogether known.

The use which can be made of white arsenic in Bordeaux mixture is obviously of considerable economic importance, and instructions have been issued by the Entomological Branch regarding its use.

Bordeaux mixture

Any mixture of copper sulphate and lime is termed Bordeaux mixture. The composition of the copper compounds of Bordeaux mixture varies according to the relative quantities of copper sulphate and lime present. The compound present in the ordinary 4.4.40 Bordeaux mixture has the formula $10Cu0.S0_3.3Ca0$ together with free lime and free calcium sulphate. If more lime is present, then there is more lime in the molecule ; if less lime is present, then there is less lime in the molecule, and there exist lower basic sulphates of copper.

The compound $10Cu0.S0_3.3Ca0$, which of course has also a certain amount of water in its constitution, is typical of the compounds of Bordeaux mixture. This salt is insoluble in water and there seems little doubt that its fungicidal nature is dependent upon the solvent action of the fungus itself.

Although this compound is insoluble in water, yet after it has been exposed to atmospheric conditions for a considerable time, copper commences to make its

appearance in solution. If this occurs on such tender foliage as peach or apple, copper injury results. The decomposition of the copper compound may be represented somewhat as follows :

$$2(10Cu.0.S0_3.3Ca0) + 15\ C0_2 = 9(Cu0)\ 2.CO_2 + 6CaC0_3 + 2CuS0_4.$$

Thus free copper sulphate is liberated. It is apparent that this reaction cannot take place while any free lime remains in the spray film. For this reason large excesses of lime are necessary on tender foliage.

While discussing Bordeaux mixture, it is appropriate to mention the copper dust recently brought forward by Mr. Sanders, and which is being so extensively used in Nova Scotia. This dust is really a Bordeaux mixture. The novel feature being the use of the copper sulphate mono-hydrate, $CuSo_4H_20$. This form of copper sulphate is a fine white powder very suitable for dusting, while the ordinary blue copper sulphate, $CuS0_4.5H_20$, does not lend itself to the same purpose.

Sulphur

Finely ground sulphur is extensively used for dusting, and has a fairly high fungicidal value. For want of more knowledge on the subject, it is assumed that the fungicidal action depends upon a slow oxidation of the sulphur to sulphur dioxide, $S0_2$, which material is known to have a powerful toxic action on all lower forms of life.

In order to reduce the cost, hydrated lime has sometimes been mixed with sulphur. When this is done, sulphur dioxide would be taken up by the lime, and it might be supposed the fungicidal value thereby lessened. However, with lime and sulphur in the presence of water a reaction occurs somewhat as follows :

$3Ca(0H)_2 + 4S = 2CaS + CaS_20_3 + 3H_2 0$ and soluble calcium sulphide is formed. Does this calcium sulphide have as high fungicidal value as the sulphur dioxide from free sulphur ? This is a point on which work is needed. Mixtures of sulphur and lime do have a definite fungicidal value, for many people use it with success. Our own experiments in Nova Scotia would strongly indicate that mixtures of lime and sulphur were inferior to free sulphur.

THE POTATO PLANT LOUSE

By Omer Caron, B.S.A., Assistant Entomologist, Province of Quebec.

When asked by a director to prepare a paper for this meeting, I decided to speak of a pest that gave me trouble the past year, since it raged in the district where I happened to be.

I feel that it will be somewhat difficult for me to interest a meeting of technical entomologists such as this one. For this reason I shall be brief and shall content myself with a discussion of some matters of a practical nature.

A few words regarding the Potato Plant Louse, called by the scientific name of *Macrosiphum solanifolii* :

This bug, with which the public is not very familiar, is not unknown to entomologists. In the United States it has been described at length and studied in those sections where it has done damage. The best descriptions help us but little however, to identify it, since it resembles very closely members of other species. The variety that interested me was the *green* variety. These plant lice, like others of the family, comprise winged and wingless, viviparous females, oviparous females and winged males.

My observations were made on the farm of the School of Agriculture, Ste. Anne de la Pocatière where I was in charge of potato spraying. The damage caused last summer was considerable. The plant lice attack by preference healthy and strong plants ; in a few days infested plants wilt, turn brown and dry up very quickly. It was evident that as a result the growth of the tubers was arrested. Happily the ravages of the insects did not extend very far beyond the limits of the farm, for an invasion of this kind is more to be feared than the ordinary invasions of the potato beetle. The latter can readily be combatted by the ordinary means, but in the case of the plant lice, a more complex treatment is necessary.

The plant lice are *sucking* insects and they do not feed on the upper surface of the leaves, but on the lower. It was necessary, therefore, in order to reach them, to use an apparatus directing a jet of spray on the under surface of the leaves, and as this operation has not been satisfactorily accomplished for Bordeaux applications, better results were not secured in this case.

The invasion of which I speak took place in the second part of the summer, that is about the 10th of August.

The plant-louse under consideration does not confine its attacks to potatoes ; when it is found near fruit trees, I have often met it on them. On fruit

trees applications of nicotine sulphate gave good results. This operation has perhaps not been put into practice in the case of potatoes, because the special spraying devices have been wanting.

Bordeaux mixture has not any noticeable action on these insects. In fields of potatoes lady bird larvae feeding on the plant lice are developed to a tremendous extent.

I do not think that we should be very much alarmed over this purely local appearance of these insects : it is well, however, to be acquainted with them so as to be able to take measures to arrest them in case of invasion, which is always possible.

In looking over the entomological literature of the United States, I note that several states, particularly Maine, have suffered from the potato plant louse. In all cases, the experts recommend applications of nicotine as the most effective, after trying out many other treatments.

I have thought well to note the above facts on account of the economic importance of its knowledge.

I shall listen to and read with pleasure any suggestions the members of the Society may offer on the subject.

SOME METHODS OF SEED TREATMENT

By Georges Maheux, Provincial Entomologist, Quebec.

This is an important question since many diseases are seed-borne. It is easy to understand some of the advantages which would accrue to the agricultural world by protecting plants against important insect and fungous enemies. If one considers cereals alone, the growers of the province would save some $30,000,000 if all seed were treated properly before sowing.

The methods employed are very simple and do not require many hours of work successfully to carry them out. If they were generally applied, the sanitary condition of our crops would improve immensely. Two crops stand out in this respect because of their importance—oats and potatoes—and this is seen when one remembers that the value of these crops amounted in 1920 to over $100,000,000 in Quebec. It is to these that we must direct most attention and if one adds spraying with Bordeaux to seed treatment of potatoes, our efforts will bring almost complete success.

The present article deals with the most important methods of seed treatment and the arrangement is on a crop basis.

I. CEREAL CROPS

Each year the fungous diseases of cereals increase in importance and especially is this the case with the oat smut and stinking smut of wheat. In some areas of Quebec loose smut of wheat is common, but generally stinking smut is by far the commoner. Occasionnaly one finds also covered smut of oats, and the smuts of barley. It must be remembered that while seed treatment is very important, it is not a panacea, and all other factors must be borne in mind : soil preparation, culture, choice of varieties adapted to the region and rotation.

The seed treatment most in favour to-day is the formalin treatment. One uses a concentration of about 1 in 300 and this is sufficient to kill the spores which adhere to the seed or glumes. There are several methods of procedure and each will be dealt with briefly.

Immersion or Soaking.—The grain is put in a sack and soaked in a solution of one pint of formalin to forty gallons of water for five minutes. This method has its disadvantages especially as the grains swell considerably and it is therefore necessary to sow carefully if the crop is put in immediately.

Spraying or Sprinkling.—In this method the same strength of solution is used, but the grain is spread out on a good floor and the solution sprayed or

sprinkled on the grain, which is shovelled well so that each grain receives a coating of the disinfectant. I must point out here that some farmers have achieved excellent results by sprinkling copiously. The disinfecting action of formalin is only completely realised when the vapor is produced and in order to ensure the effect of formaldehyde vapor on the grain it is necessary to cover it with sacking for five or six hours. Experiments made by farmers have shown that even if left covered for as long as twelve to eighteen hours there was no injury to the grain and the crop is healthy.

Concentrated Solution.—This is a recent method which has the advantage of avoiding the necessity of handling a large quantity of water. It is carried out by spraying with a concentrated solution consisting of one pint of formalin with one pint of water. This is sufficient for fifty bushels. The grain is shovelled well during the spraying and is then covered for several hours. For my part I prefer the previous treatment, because it has given the best results in our county demonstration experiments.

The treatment with formalin we owe to the work of Bolley, Swingle, Genther, Arthur and others, but it is not the only method in use. Before the use of formalin came into vogue and towards the end of the nineteenth century, Benedict Prevost had succeeded in controlling stinking smut of wheat by soaking it in a solution of copper sulphate. Mathieu de Dombasle verified the method but the growers, believing this substance to be very poisonous, continued to use a simple heating or sulphate of soda followed by heating. Kuhn again used the method and Linhart perfected it. The copper sulphate treatment is now the only one in use in Australia.

Among the diseases of cereals we find two in which the organism does not exist on the surface but lives over in the seed itself. These are the loose smut of wheat and of barley. In this case, therefore, formalin treatment is not applicable, but Jensen discovered that by careful treatment with hot water these diseases may be controlled.

Hot Water Treatment.—In this method it is necessary to work with a temperature which will kill the organism without affecting the germination of the grain. This is done by using three baths with a gradually increasing temperature as follows :

1. Soaking at 86° F. for 4 hours.
2. Soaking at 112° F. for 15 to 20 minutes.
3. Soaking at 129° F. for 10 minutes.

The first bath facilitates the heat penetration of the later soakings which are of much shorter duration because of the higher temperature. It is import-

ant to note that the last bath must not rise above 129° F. or injury to the grain will certainly occur.

II. FORAGE CROPS

Corn smut does not occur extensively in this province and it usually suffices to destroy the smut boils when seen. The spores remain in the soil or are found in the manure and according to Howitt (Ont. Bull. 258) neither formalin nor copper sulphate treatments are efficacious.

Our growers ought always to protect maize against another enemy. In the beginning of summer our fields are invaded by crows which live upon the corn grains principally. It is necessary, therefore, to find some treatment which will prevent damage by crows, which will not be harmful to useful birds and which will not injuriously affect the embryo. There is a choice of two methods. The first and better consists in the use of tar as a repulsive agent.

1. *Tar.*—This is used at the rate of a soup-spoonful to a half bushel of corn. The grain is first placed in warm water and then drained. The tar is then sprinkled so that each grain is well covered. It is then left to dry, or is rolled in ashes, dust or plaster so that the grains do not adhere one to another. In normal years this treatment does not retard germination and only in very dry seasons does any injury to germination happen.

2. *Red Lead.*—Farmers, Bulletin 1102 advises the use of this substance which has given good results. The grain is dipped in dilute glue so that the powder will stick and the read lead sprinkled on it until it is well colored.

Others use petroleum, carbolic acid, fish oil ; but all these injure the grain and reduce germination.

III. OTHER CROPS

If one wishes to improve the potato crop seed tuber disinfection is necessary against such diseases as black leg, rhizoctonia and scab. For this formalin treatment is best.

1. *Formalin method.*—A solution of formalin is prepared of a strength of one pint in 30 gallons of water and the tubers are soaked in this for two hours.

2. *Corrosive Sublimate.*—This is used at a strength of 1 in 1000 but it is a dangerous poison so that it is not in common use by farmers.

Cabbages, etc. suffer from black rot and bacterial wilt, which are seed borne diseases.

Stevens and Hall (Diseases of Economic Plants) recommend soaking the seed in the following solution :—

1 part of corrosive sublimate.
2 parts of hypochloric acid.
1000 parts of water.

On the other hand Duggar recommends a bath of fifteen minutes in a solution of corrosive sublimate 1 in 1000. Howitt finds that the same results are obtained by using formalin 1 in 1000 for fifteen minutes.

Finally Geunaux finds that for the root rot of cabbage copper sulphate (1%) can be used in place of formalin if the injury is serious.

Onion bulbs are disinfected by using commercial formalin 1 in 300(Geunaux).

In order to control onion smut contaminated soil should be disinfected with formalin 1 in 300. This requires 125 to 150 gallons per acre (Howitt, Ont. Bull. 258). Another method consists in sowing the seed and watering with dilute formalin solution before covering the seed.

Beans and peas infested by weevils can be treated with carbon bi-sulphide in a closed vessel. The vapour—dangerous to handle because it is very inflammable—kills the insects in the seeds in 48 hours. It is used in a concentration of three ounces to a barrel.

In certain cases soil treatment replaces seed treatment when the spores live over in the ground and not on the seed.

In order to prevent diseases in the seed bed of tobacco, one sterilizes the soil with formalin 1 in 100 or with steam. The same method is used in avoiding lettuce drop.

In forestry nurseries the soil is disinfected with formalin 1 in 50, or with sulphuretted hydrogen (Truffaut), or with carbon bi-sulphide.

In some districts growers complain of the ravages of rodents which attack and destroy corn when sown. Farmer's Bulletin 932 states that this trouble occurs in certain of the western sections. It is suggested that to control the following method be employed. A soup-spoonful of tar is added to a gallon of boiling water which is then allowed to cool. When cool the grain is poured in and stirred about for some minutes. No injurious effect is noticed in the germination of corn so treated. We have not had occasion to observe the ravages of rodents in Quebec in anything like an epidemic.

THE DISCOVERY OF THE EUROPEAN CORN BORER IN SOUTHERN ONTARIO

Leonard S. McLaine, Chief, Division Foreign Pests Suppression, Entomological Branch, Ottawa.

Ever since the European Corn Borer was realized to be a serious pest, that is in the summer of 1918, the Dominion Department of Agriculture has taken steps to warn the general public of the danger of introducing the pest into the corn growing sections of Canada, as well as to find out if the pest had already been introduced.

It was with this latter object in view that scouting work for the European Corn Borer was carried on in the Maritime provinces in the summer of 1919. In the fall of the same year this insect was found in western New York bordering the shores of Lake Erie. Through the co-operation of the United States officials in charge of the work, two Dominion scouts proceeded to the New York outbreak to receive instruction in scouting for the pest. They later scouted in Welland County, Ontario, but the work was soon discontinued on account of the lateness of the season and the general weather conditions. Plans were formed, however, for extensive scouting to be carried on in southern Ontario during the summer of 1920, special attention being paid to the districts bordering on Lake Erie.

Early in August two scouts equipped with motorcycles, started the scouting work as the corn was coming into tassel. On August tenth Messrs. Keenan and Simpson found some suspicious looking larvae in a field of ensilage corn, near Lorraine Station, Humberstone Township, Welland County. The larvae collected were very small and identification was difficult. These and later collections were forwarded to Dr. J. M. McDunnough, Chief of the Division of Systematic Entomology, for determination and were identified by him as being larvae of the European Corn Borer (*Pyrausta nubilalis* Hubner). Plans were then formulated to determine the area infested by the insect.

On August 22nd a farmer in the vicinity of Aylmer, Ontario, submitted samples of larvae to the Dominion Entomologist and these were also determined by Dr. McDunnough as those of the European Corn Borer. A preliminary examination of the fields in this locality indicated that the intensity of the infestation was much greater than that in Welland County.

The season was advancing rapidly and with apparently two distinct infestations to deal with, it was necessary to take on additional men and furnish better means of transportation. The Ontario Department of Agriculture cooperated in this scouting work through the courtesy of Professor L. Caesar,

by supplying a Ford Car and three or four men. A Ford car and additional men were also engaged on the work by the Entomological Branch. As a result of this increase in staff, better transportation facilities, and exceptionally fine weather conditions, the scouting work proceeded at a rapid rate and the infested area, as far as we are aware, was covered by October 23rd when the work was closed down for the season.

The amount of territory covered by this field scouting includes thirteen counties, of which seven were found to be infested ; in all one hundred and five townships in the above counties were inspected of which thirty-five were found to be infested. The scouting work indicated that there are two distinct and more or less widely separated infestations of the European Corn Borer, known in southern Ontario at the present time. Two separate attempts were made to connect these infestations but without success.

Infestation No 1 centers around Ridgeway and Crystal Beach, it extends along the Lake Erie shore from Fort Erie on the east to Dunnville on the west and Stevensville on the north. It covers approximately three hundred and forty square miles.

Infestation No. 2 centers about St. Thomas in Elgin county, it extends from Bayham township on the east to Harwich township on the west, and to Farquhar, Usborne township on the north. It covers approximately three thousand four hundred and thirty square miles.

The Ridgeway and Crystal Beach infestation is very light in character and, with the exception of one field, the amount of damage done so far is practically negligible. It is confined to a comparatively small area and only a few borers were found in any one single field. As compared with infestation No. 2 it is evidently of recent origin and from evidence gathered from various sources it appears as if the pest was introduced into this district on shipments of sweet corn on the cob, from the infested areas in western New York. Crystal Beach is a summer resort largely used by residents of Buffalo. During the summer months, excursion steamers run at frequent intervals between Buffalo and the resort. As the trip only takes one hour, it is customary for the residents to do much of their shopping in Buffalo. There is also a rapid ferry service between Black Rock, N. Y. and Fort Erie, Ontario, and hundreds of automobiles come across on the ferry on fine summer days.

Judging from observation already made, Infestation No. 2 is apparently of much older origin. The area infested is ten times as large as No. 1 and the degree of infestation in the centre of the area very much greater. The amount of field infestation runs from nothing to 99 per cent. In one field near Union Station, consisting of eight acres of flint corn, a very careful study of conditions was made and it was found that ninety-three per cent of the plants had been or

were infested by the borers. Dent corn does not appear to be as readily attacked as flint, as the highest percentage of infestation found in a field of dent corn was forty-five. Intensive investigations were started soon after the borer was found, to determine the amount of actual damage done by the pest. These are still being carried out by Mr. H. G. Crawford, of the Division of field crop and garden insects, who has immediate charge of the work, and the final results have not yet been compiled.

The United States officials are strongly of the opinion that the European Corn Borer was introduced into the United States on shipments of broom corn imported from 1909-1912. This was substantiated by a shipment of broom corn being received at the port of New York from Italy, during the spring of 1920, heavily infested with borers. Enquiries conducted by the Entomological Branch, have shown that in 1909 the largest corn broom factory in Canada was operating in the St. Thomas district. Between 1909-1911 hundreds of tons of broom corn were imported from central Europe by this firm, on account of the shortage of broom corn in the southern United States. Although this evidence can by no means be regarded as conclusive, nevertheless it is the most important that has been obtained to date.

In order to prevent the spread of the borer by artificial means, an embargo was passed on November 29th, 1920, which prohibits the movement of corn fodder or corn stalks, including broom corn, whether used for packing or other purposes, green sweet corn, roasting ears, corn on the cob or corn cobs from the areas infested by the European corn borer. Five exceptions are made to this Quarantine, the two chief ones being that it shall not apply to clean shelled corn or clean seed of broom corn, and the second permits the forwarding of seed corn on the cob to exhibitions of recognized standing, such exhibits are examined at point of destination by an authorized inspector.

GERMINATION OF TELIOSPORES OF PUCCINIA ANTIRRHINI

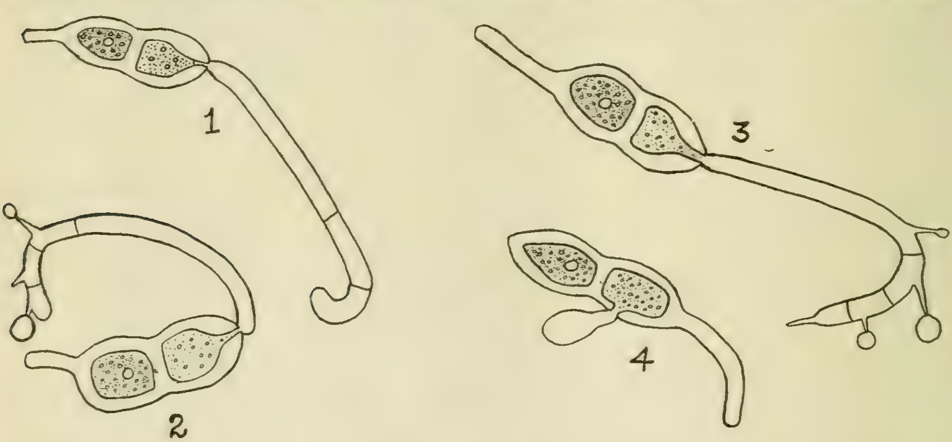
By J. F. Hockey, B.S.A.

At the twelfth Annual Meeting of this Society, Professor B. T. Dickson, Macdonald College, presented a paper—"Some Plant Diseases in the Greenhouse,"—in which he made reference to a rust on snapdragons (*Antirrhinum Majus, L.*) In that paper reference was made to the finding of both urediniospores and teliospores, the latter being mush less plentiful. The urediniospores, as stated, germinate readily in a few hours, but the writer has been unable to find any record of the germination of teliospores in available literature. It is the purpose of this paper to present the results of experiments, carried on under Professor Dickson, on the germination of the teliospores of *Puccinia Antirrhini.*

Source and Description of Material

The material for these experiments was obtained from the College greenhouses on January 5th, 1921. A crop of snap-dragons had been growing in one of the beds but, owing to a severe outbreak of rust, the entire crop was pulled up and thrown on the compost heap. Specimens of badly diseased plants were taken from this pile the following day, the plants having been severely frozen.

The rust was determined as *Puccinia Antirrhini*, Diet. and Halw., according to the description by Saccordo (7). The teliospores were found on the branches and stems of the plant in elongate and round sori either mixed with



Germinating teliospores of *P. Antirrhini.* Figs. 1 and 4, after 24 hours in hanging drop. culture. Figs. 2 and 3, after 48 hours in culture, showing four-celled promycelia with sterigmata bearing sporidia on their tips.

urediniospores or in separate telia. It cannot be said that the teliospores are produced only in the elongate sori. as many were found in the round sori commonly considered to be uredinia. The teliospores are thick-walled and two-celled with a slight constriction of the spore wall at the septum. They are darker than the uredinio-spores and usually bear persistent pedicels giving them a club-shaped appearance.

Scope of Experimental Work

Peltier (6, page 538) writes : "All efforts to germinate the teliospores have failed. The spores were subjected by the author to alternate wetting and drying to high and low temperatures and to various outdoor conditions through the winter and summer. The gelatine plate method was also tried under different conditions, but with no success." No details are given concerning the lowest temperatures to which the spores were subjected in the outdoor conditions.

In order to corroborate these results, in part, hanging drop cultures of teliospores which had been frozen for one day were made in distilled water. After one day 5% of the teliospores had germinated from one cell, usually the apical cell. After two days 14% had germinated with the production of four-celled promycelia, some bearing sporidia on short sterigmata. This result led the writer to carry on further tests to determine, if possible, the maximum germination after the spores had been subjected to outdoor conditions for varying periods.

Other experiments to determine whether the rust was autœcious or heterœcious were also conducted, but the writer was unable to complete them. However, the results obtained to date are given here.

Experiments in Germination

All hanging drop cultures were made with ring cells and incubated in a moist chamber at room temperature. The most uniform results were obtained by the use of distilled water and tap water. Spore cultures were also made in 1% saccharose and 1% destrose solutions, but only slight germinations were obtained. The results of the experiments may be tabulated as follows :—

Period Frozen	*Date Cultured*	*Media*	*Per cent of Germination*
1 day	Jan. 10	Aq. dist.	14%
7 days	Jan. 11	"	16%
7 days	Jan. 11	Tap Water	12%
14 days	Jan. 18	Tap Water	22%
14 days	Jan. 19	Aq. dist.	14%

The viable spores germinated in two days and only in rare instances did any germinate after two days in the hanging drop.

Spores taken from a plant which had been frozen seven days, kept at room temperature four days, then frozen again for four weeks gave only a slight germination (2%).

The promycelia varied in length from one to four times the length of the spores. The sporidia were hyaline, spherical to obovate, smooth, varying in diameter from 4—9 microns.

A record of the meteorological observations for the month of January was obtained from McGill University in order to have accurate data of the temperature for the period January 4th to 18th inclusive.

Days.	*Mean.*	*Max.*	*Min.*	*Range.*
January 4.	32.9	36.8	29.0	7.8
5.	29.0	32.2	23.7	8.5
6.	17.6	23.7	11.8	11.9
7.	14.8	23.5	6.0	17.5
8.	24.0	27.0	21.0	6.0
9.	22.5	28.0	19.8	8.2
10.	25.8	32.8	19.9	12.9
11.	25.6	31.5	21.8	9.7
12.	13.8	18.0	6.0	12.0
13.	3.5	10.0	–4.3	14.3
14.	17.3	27.0	6.3	20.7
15.	28.1	31.0	20.0	11.0
16.	8.5	19.0	.5	18.5
17.	6.7	19.4	–7.5	26.9
18.	–9.8	–6.8	–14.2	7.4

From this record we are able to obtain the lowest and highest temperatures to which the spores were subjected in the different trials. Those that were frozen for one day (January 4-5) were under weather conditions ranging from 36.8 to 23.7, with a mean temperature of 30.6. The spores subjected to outdoor conditions from January 4-11 suffered a range of temperature from 36.8 to 6.0, with a maximum range on January 8th of 17.5. The mean temperature for these seven days was 24.0. The spores that were left outside until January 18th underwent a range in temperature of 51.0 in the two weeks, with the lowest mark—14.2 on the day they were brought indoors. The mean temperature for the two weeks was 18.6. All temperatures are in Fahrenheit Degrees.

Experiments in Inoculation

Seedling plants of *A. Majus* were inoculated with (a) germinating teliospores bearing sporidia, (b) teliospores from plants which had been frozen two weeks

and (c) viable urediniospores. The plants inoculated with urediniospores were the only ones on which infection was successful. These developed characteristic uredinia in about two weeks. No infection was obtained from the sporidia.

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METHODS OF PROLONGING THE DURABILITY OF FENCE POSTS

BY J.-A. ROY

It is becoming more and more difficult in Canada to-day to get fence posts of wood that is properly durable. This scarcity is not only tending to enhance the price of the posts, which are so necessary to farmers, but further the products offered are often of secondary quality, or too small in size.

Cedar wood, which resists decay for a long time, even in wet soils, is the kind most in demand for the purpose, but, like others also very suitable, is becoming more and more rare. Such trees as the oak and the chestnut yield wood of great durability, but these are highly valued for other purposes and the idea of using them for fence posts is generally out of the question.

This country possesses many species of forest trees less durable than the cedar, such as poplar, cypress, spruce, fir and willow, and these absorb antiseptic dressings with which they may be treated more easily than hard woods. As the cost of cedar and other durable kinds of wood has increased, the use of inferior varieties has become more common ; if these latter last but a short time, however, it becomes an expensive matter to replace them. In order to practise economy to the best advantage, the cost of any treatment that will prevent, or at least, retard, decay should be considered.

I urge the desirability of practising economy—and very considerable economy—in money outlay, as well as in quantity of timber used.

Let us consider the case of a farmer who possesses an area of land 14,400 feet long by 720 feet broad. As most farmers make their fences with rails, a double quantity of supporting posts will be necessary. Assuming that the stakes are at a mean distance of fifteen feet, one from the other, at least two

thousand of them will be needed in forming the fence all round the area. Purchased stakes cost on the average 20 cents each. This would mean an initial cost of from $350.00 to $450.00.

The second item of cost to consider is that of fixing the posts in position. The farmer will say : "That costs nothing : I do the work myself with the help of my son." But while the farmer and his son are thus occupied, they cannot be doing other work, at which it must be remembered they might be earning $2.50 or $3.00 per day. If the construction of the whole fence occupied the two men for seven days, then we must add to the cost of the material the sum that the two men would have earned had they hired out their labour : from $35.00 to $42.00.

The cost of the posts and their installation will amount to from $400.00 to $500.00, this not including the cross rails. If the fence is to be of wire, the cost of this would be about the same as if rails were used. With a wire fence, posts are used singly. They must be well made in order to serve their purpose well, and be somewhat larger in size than is necessary when rails are used. The price of such posts would be from 25c to 35c each, so that the total cost for all the stakes—not including cost of installation—would be from $250.00 to $350.00

This expenditure for fresh posts will, in general, have to be repeated every eight or ten years, but if the posts have undergone any suitable treatment, especially that with creosote, they will last from twenty to twenty-two years, according to the method employed.

Economy in Material

I am told that there is not necessarily any waste of material in cutting out posts. The tops of trees are used for this purpose, when trees are cut for firing, or in making a clearing. Every farmer knows how this is done. When a fence needs renewal, he goes over his wood lot and looks out particularly for a suitable cedar tree, and when such a one is found, it is cut down. Sometimes two or three posts are obtained from a single tree ; so that it will be at once realised what a number of trees are required to give two thousand posts. After a few years it will generally be found that the quantity of cedar available is very limited, or that there is none at all. The timber is in such demand that most farmers cut down and sell their cedars.

Under such circumstances the farmer would either content himself with using material less durable than cedar wood, or he might purchase cedar, or other hard wood, from outside.

If the farmer finds himself obliged to use posts of a species less durable than cedar, he will, no doubt, be able to obtain sufficient material from the trees cut down yearly for firewood. Let us consider again the case of the man previously referred to, who, we assumed, is obliged periodically to replace all his fence posts, and who needs at least two thousand stakes for setting up his fence. To get these two thousand stakes it would be necessary for him to cut down such a number of trees, that the refuse left after obtaining the posts would provide all the firewood he needed for a long time. If the material needed is obtained in the ordinary clearing work on the holding, the surplus wood not required at

home could be sold at a profit. Considering these several points, it may be said then that by employing as posts material treated with antiseptic dressings, which make the wood more lasting, the quantity of cedar in the wood lot would be conserved, the area cut periodically for firewood would be lessened, or, on the other hand, would yield a good profit and further, a good sum of money would be saved on the maintenance of the fence.

If the farmer is obliged to purchase the material for his posts, the consideration of the necessity for economical expenditure becomes obvious.

Kinds of timber that may be used

In districts where post material can be obtained easily and at not too great expense, it matters little what kind of wood is used, but for preference one would select those kinds which last as long as possible. But in parts where timber is not plentiful, one must exercise more care in the choice of the trees that are to be cut down for making into fence posts. Apart from the cost, which is always the most important matter, the following points must be considered :—(1) durability of the wood, (2) symmetry and size, (3) capacity of the wood to hold a nail or staple, and (4), the ease, or otherwise, with which the wood absorbs the antiseptic dressing applied.

(1) *Durability.*—In a soil that is always wet, fence posts last longer than in a site sometimes wet and sometimes dry. Further, posts from trees of slow growth are always more durable than those from quick-growing trees.

(2) *Shape.*—The best fence posts are those from coniferous trees (soft wood) such as the cedar, pine, spruce, etc., and every fence made with stakes of these kinds has a much neater appearance than those having bent or twisted posts.

(3) *Capacity to Hold Staples and Nails.* If it is necessary to use staples and nails, then it is certainly desirable that the posts should be of hard wood.

(4) *Capacity for Absorption of Antiseptic Dressings.*—If posts are employed which have not been submitted to antiseptic treatment, then the time they will last depends to some extent on the amount of heart wood they possess. For this reason posts that have been "squared" last longer. If the posts are to be treated with antiseptic solution, it is better not to remove the sapwood which absorbs the solution better than the heartwood. So far as possible, it is better that the heads of the posts should be cut or shaped to a point, so that rain water shall easily run off. If frost has been found to loosen posts when placed in the ground, they should be sharpened at the lower end before fixing, so that they can be well driven in with the aid of a mallet. In all cases, whether the posts are treated with antiseptic or not, it is a good plan to remove the bark, which offers practically no protection. The bark should certainly be removed thoroughly if the wood is to be treated, for if the inner bark is left on, it has the effect of reducing penetration by the fluid.

Before deciding upon any system of treatment whatever, the net cost should be estimated, as influenced by the following factors : (1) the purchase price of the posts, (2) the cost of removing the bark and seasoning the wood, (3) cost of transport from the place where the trees were cut to where they are to be used, (4) the cost of fixing in position, and finally, the expense entailed by the treatment process.

In order to arrive at a clear idea of the economy, or otherwise, of treatment, the above items of expense will have to be added together, and the total divided by the number of years that a post treated with antiseptic will last, and again by the number of years that an untreated post lasts, and so at last the cost per post per year is known. If ordinary material, needing treatment before using as posts, is employed, the initial expense is less, because time and effort have not been expended in searching for any special kind of wood. The cost of transport should also be small in such a case, i. e., if any ordinary wood,found in abundance on practically every farm, is used. The cost of removing the bark and of seasoning will be higher, for it is necessary that the wood be carefully seasoned and the bark thoroughly removed, before it is used.

The cost of treatment is the most important item, and this will depend on the particular preservative and on the method by which it is applied. If the farmer uses only treated posts, then the annual charge for maintenance will be much less, as the posts last so much longer. A point that must not be forgotten is that the period of treatment for the wood must be quite short.

Choice of a preservative

Experience has shown that creosote, or anything prepared from oil of tar, is the best preservative for wood that is to be used in wet places, and this for two reasons : (1) Creosote is a chemical poison for the different fungi which bring about the decay of the wood and also for the numerous insects which destroy it ; and (2) Creosote is a heavy oil, insoluble in water. If the wood is thoroughly saturated with creosote, it will take up only very little water. As moisture and air are necessary for the growth of fungi, wood treated in this way will remain sound for an indefinite period.

Other substances can also be employed such as Chloride of Mercury, or of Zinc, or even Sulphate of Copper, or one of many other compounds which are veritable poisons for fungi and insects, but these are all soluble in water and would be dissolved out when the post was established in a damp soil. The wood would then be exposed to attack by agents of destruction.

Creosote is an oily product obtained in the manufacture of coal gas, and is a substance more or less variable in quality. The heavier or more dense the oil that is used, the slower does it penetrate into the wood under treatment ; but such oil does not evaporate readily either during treatment or after. If a lighter liquid is used, penetration takes place readily, but evaporation is also fairly rapid.

Creosote can be obtained in most towns where coal gas is made. In Canada, in 1915, the price varied from ten to twenty-five cents a gallon, and has not advanced much to-day. The rather wide variation in price already mentioned depends on the quality, the specific gravity, the quantity purchased and, finally, the cost of transport.

Kinds of Wood to Select for Treatment

The selection of kinds of wood that will be suited for our purpose after treatment depends on local conditions. In the Maritime Provinces, the spruce, the fir and the pine offer material that can be economically treated. In Quebec and Ontario, in addition to these three kinds,there are also the cypress and the willow. In British Columbia, the western pine and the poplar are plentiful, and suitable for the purpose. An advantage of this treatment by creosote and other antiseptics, is that it allows the use of a cheap kind of wood, and the variety chosen will depend on the purchase price and the method of treatment adopted.

Preliminary Preparation of the Wood

When the kind of wood to be used in making the posts has been decided upon, it is prepared in a special manner before treatment with the antiseptic. The trees, or parts of trees, are cut out in the autumn, or early in spring, before the sap has begun to rise in the tree.

The stakes are piled up in tiers, each of 4 or 8 stakes, each set laid crossways on the previous lot, until the pile contains from fifty to sixty posts. These piles are arranged at from twelve to fifteen feet from each other. As the result of this arrangement, the posts will be well seasoned in the summer and will be ready for the creosote treatment in the early autumn. The head of each post should be cut to a point or edge.

General Object of the Treatment

The aim of the treatment is to secure a penetration by the creosote or other liquid as deeply as possible into the wood, using the smallest possible quantity of liquid and with evaporation reduced to a minimum during treating.

Farmers who have a good deal of fencing to attend to and who use a great number of posts soon become quite capable of carrying out the different methods of treatment described below.

Setting stones round the Bases of the Posts

Mr. Weiss, in his book entitled "The Preservation of Structural Timber", page 174, suggests that if one can get stones in sufficient quantity it is a good plan, after the post has been placed in the hole dug for it, to fill in with stones, as this would prevent the growth of vegetation, which would otherwise injure the base of the post.

Carbonisation

Another method of treatment is to first soak the foot of the post in crude tar oil and then slightly carbonise this portion in the fire. Some experiments carried out at the Wyoming Experimental Station, Ohio, on this method, have given satisfactory results.

Diagonal Perforations

This method consists of boring a number of holes, each about half an inch in diameter and three inches deep, the holes being two or three inches above the soil level and pointing in a slanting direction towards the base of the post. These cavities are filled with some preservative, such as a solution of sulphate of copper or of mercuric chloride, and the mouth of the hole is afterwards closed. When the liquid so enclosed has been absorbed into the wood, the operation is repeated, Mr. Weiss does not recommend this method and gives as his reasons that the boring of the holes weakens the wood, that the liquid enclosed does not reach all parts of the wood, and finally, that the results obtained do not always justify the expense.

Method of Applying Antiseptic Dressing by a Brush

This is the most economical method of applying the dressing to the posts, and it is from the point of view alone of economical application that it is to be recommended. The method followed is simply to give to the lower part of the post at least three dressings of hot creosote liquid by means of a paint brush, or any other suitable brush. The creosote is warmed, and kept hot throughout the process of treatment. In carrying out this method all cracks and holes in the wood should be filled with the liquid used, and one coating should be allowed to dry thoroughly before the next is laid on. While the dressing is drying, the post is placed with its base upwards so that the liquid has additional opportunity to soak up into the wood. So far as possible this drying should take place while exposed to bright, warm sunshine. If the post is cold, or if the creosote cools too quickly, it tends to solidify on the outside and does not soak into the interior of the wood. If it is desired, a coating of creosote can also be given on the part of the post that will remain above ground. It is customary to treat only the lower part of the post, i. e. the portion that will be in the soil, and also the part up to six inches above ground. This application of creosote by the brush method causes the liquid to penetrate about a quarter of an inch into the wood and this will increase the life of the posts by at least ten years in the case of spruce, pine and poplar material.

The Dipping Method

This method is advised only in cases where there are but a few posts to be treated. Creosote, or any preparation with creosote as a base, are the best preservatives to employ. The liquid in which the posts are dipped must be warmed to a temperature of at least 150°F. and the time of each dipping should be from 15 to 20 seconds. The lower portions of the stakes must be dipped two or three times, from the base up to a point that will be a foot above the surface of the earth when the post is fixed. Between these several immersions the posts must be allowed to dry thoroughly, or in other words time must be given for the liquid to penetrate the wood.

The Open Tub Method

This is a simple method of treatment and gives a better return than the preceding one, but the apparatus needed for the carrying it out is more extensive. The posts are heated in a hot bath of creosote which makes the air in the vessels of the wood expand, and converts into vapour the moisture that is in the wood. As a result, part of the contained air and of the moisture is removed. The posts are, after this, placed in a cold tub or copper, or allowed to remain and get cool in the bath, which was previously heated but is now cooled. The contraction of the air and the condensation of water vapour, which take place at the reduced temperature, bring about a partial vacuum, and, as a result, the preservative liquid is forced into the wood by atmospheric pressure. The receptacles used, as well as the details of the method employed, depend on the judgment of the operator and the cost of the material.

An open tub, comparatively inexpensive, which can be employed on all farms consists of a water-tight barrel, three pieces of iron piping and the necessary fittings. One piece of piping passes into the barrel near the bottom, a second higher up, while the third piece connects these two. A number of posts are placed in the barrel, and creosote is poured in to a level above the upper piece of piping. Then a fire is lit beneath the lower pipe, care being exercised that the barrel does not take fire, for creosote is very inflammable and a single spark may be the cause of the destruction of the whole. The heat will circulate slowly and the tar will be raised to boiling point. The heat must be maintained at this temperature, but not allowed to go above 220°F. The loss due to evaporation will be considerable and will vary from 10 to 20 per cent, according to the density of the liquid. When heating is discontinued the stakes are left in this bath so long as any bubbles of air continue to rise to the surface. The time necessary for treatment varies with the nature of the wood, the amount of bark, and the dryness of the material. It may be anything from one to six hours being a matter for the judgment of the man who is carrying out the work. It is advisable to make a few preliminary trials to ascertain what length of time gives the best results. When it is considered that the heating has proceeded far enough, the fire is extinguished, and the creosote allowed to cool down, but the stakes remain in the liquid for three or four hours longer. This time having elapsed, they are placed in an empty barrel, but they are now upside down, as compared with their position when being boiled in creosote. This is done so that the excess of creosote which has not soaked fully into the wood may have an opportunity of passing down into the portion which was previously uppermost, and therefore not so well penetrated by the creosote.

If it is preferred, however, the posts may be left standing just as they were in the tub in which they were treated, and the surplus creosote collected and used again.

This "open tub" method permits of great variation in the details of treatment and also certain variation in the plant used.

The posts are sometimes lifted out from the tub containing the hot creosote and placed in another receptacle containing cold creosote, where they remain until a sufficient degree of penetration has been reached. If this method is followed, the barrel with the hot liquid can be at once refilled with posts and the operation started again immediately. In this way there will be an economy of time. A wooden vessel sufficiently large to allow the posts to be laid in it on

their side, i. e. completely submerged, is the best to use for the cold liquid. The foot, or lower part of the post, which has been charred or slightly burnt in the fire, will absorb a large quantity of creosote, while the upper part will absorb sufficient to prevent rapid decay. This is a good method of treatment for the more perishable kinds of wood, such as the willow, the poplar and the maple. The same results may be obtained by placing the foot of the post in a tub filled with creosote and, by means of a brush, apply two or three coatings of creosote on the upper part.

The "open tub" method is quite satisfactory when only a small quantity of posts are to be treated, but with a larger quantity it is desirable to have a permanent plant installed. The wooden vessel must be replaced by one made of galvanised iron, in order to avoid the possibility that the former may not always be watertight. The kind of fire described as used with the "open tub" method results in a loss of heat, while, with an iron vessel, the fire can be placed immediately beneath and a chimney of stone or brick constructed. If one prefers to use steam heat, a coiled pipe inside the galvanised iron vessel will prove satisfactory. This prevents all danger of fire and allows the creosote to be kept always at the same temperature with the minimum of evaporation. The piping in the "cold" vessel affords opportunity of again heating the creosote if any risk of solidification exists.

Cost of Treatment

From the following figures, given by Mr. Weiss, ("The Preservation of Structural Timber," page 178), the cost of treatment by the Brush Method, the Dipping Method and by Impregnation can be calculated :

In 1915 the price of	creosote was	2c	per lb.
" "	zinc chloride was	5c	" "
" "	mercuric chloride was	70c	" "
" "	sulphate of copper	5c	" "

In the case, therefore, of a post seven feet long and six inches thick at the top, the cost by different methods would be :

The Brush Treatment	4c to 6c.
The Dipping Method	5c to 7c.
Method of injection with Sulphate of Copper, Zinc Chloride or Mercuric Chloride	3c to 7c.
Injection with Creosote	12c to 20c.

If the whole post was "injected," the cost of this method would be doubled.

The following table shows the results of treatment by the different methods in preserving the posts :

	Length of Life of Posts in Years.	Cost per Post, after Treatment and Placing in Position.
Non-treated posts	5 years	20c.
Brush treatment	9 "	25c.
Dipping method	11 "	26c
Injection with Chloride of Zinc, or Mercury, or Copper Sulphate	12 "	25c.
Injection with Creosote	21 "	40c.

Mr. Crumley has given us the following facts in regard to fence posts :—

(1) A large post lasts as long as a small one.

(2) It does not much matter which end of the post is placed in the earth, but preferably it should be the larger end.

(3) In clay soils the upper part of the posts will decay more quickly than the lower, while the opposite effects will be noticed in soils of an open kind, i. e. sandy or gravel.

(4) The posts will last all the longer in a soil that is always moist.

(5) Posts from trees that have grown fast and in the open air are not so durable or lasting as those which have grown in the forest.

(6) It is not a good plan to cut wood for fence posts after the sap has begun to rise.

(7) The heart wood of a tree is not so good as that nearer the exterior.

I give below a table which contains certain information compiled by the Forest Service of Quebec :

	1916	1917	1918	1919
Production of Fence Posts in the years	189,749	296,774	235,200	89,245

This gives for the four years a total production of 610,968 posts, of which the cost, when fixed in position, might be estimated at $122,193.00, or about $30,548.00 per year. As I have remarked earlier, if the posts are not treated with creosote, this outlay would have to be repeated yearly. We may now consider the total and the annual expenditure involved in treating the above number of fence posts by the methods mentioned.

Method of Treatment	Length of Life of the Posts.	Total Cost.	Annual Cost
"Brush" treatment	9 years	$ 152,742.00	$ 16,971.33
"Dipping" method	11 years	158,851.68	14,441.06
Injection with Chloride of Zinc, Chloride of Mercury, or Copper Sulphate	12 years	152,742.00	12,728.50
Creosote	21 years	219,948.48	10,473.73

If I now make a comparison between the results of the two extreme cases i. e. the posts which get no treatment and those treated with creosote, I find that, proceeding on the first method, at the end of twenty years I should have required 2,443,872 posts, at a cost of $488,774.00, whereas, if treated with creosote, only 610,968 posts would have been needed, of which the cost would be $219,948.48. These figures, you will agree, speak for themselves and express forcibly the economy involved in the creosote method of treatment.

PLANT DISEASES OF 1920-21

B. T. Dickson, Professor of Botany, Macdonald College, P. Q.

In giving this brief account of the commonest diseases of the year, I have thought it best to deal with them on a crop basis where possible.

Orchard.—During the season there was little apple scab (*Venturia inaequalis*) but unfortunately an abundance of black rot (*Physalospora cydoniae*). This latter appears to be in sequence with the excessive winter injury arising from the severe winter of 1917-18. These two—winter injury and black rot—constitute one of the important orchard problems in Quebec.

There were sporadic cases of silver leaf (*Stereum purpureum*).

Field and Garden.—Pea Beans (*P. vulgaris*) were severely attacked by *Ps. phaseoli* causing blight, and both mosaic and anthracnose were present, the latter only to a slight extent. Broad bean (*Vicia faba*) suffered to the extent of 50% with mosaic.

Sweet peas likewise were affected by mosaic and distinct mottling was observed in the flowers of the red purple varieties.

Clovers generally developed mosaic to a considerable extent.

Red Clover (*T. pratense*) in the experimental plots showed over fifty per cent. In the field yellow sweet clover (*M. officinalis*) and white sweet clover (*M. alba*) were severely affected. Black medick (*M. lupulina*) and Alsike clover (*T. hybridum*) suffered from the same disease, but no percentage counts were taken. Alfalfa (*M. Sativa*) exhibited a speckling similar to that of mosaic, but it cannot yet be stated definitely that alfalfa also has its mosaic.

Experimental work still in progress shows that aphids are albe to inoculate and cross-inoculate *T. pratense, T. hybridum* and *M. lupulina..* Indications are favourable that the same aphids cause the above mentioned spotting on alfalfa. I have not been able to cross-inoculate from the sweet clovers to other clovers by aphids.

Tomatoes, potatoes and tobacco all developed mosaic. In the tomatoes there was 52% of infected plants and mottling of the fruit was quite common. Streaking of light and dark green was observed in the case of tobacco plants with mosaic.

The potato seed was carefully selected, but in spite of this there was approximately three per cent mosaic, five per cent true leafroll and eight per cent

leafroll caused by *Fusarium sp.* Bacterial stem-rot or black leg (*B. phytophthorus*) was present in one range, but was not serious.

No late blight (*Phytophthora infestans*) appeared until September, when during the last two weeks of the season we had heavy warm rains. As a result of these rains there was a heavy loss of potatoes in storage principally from Fusarium rots—combined with some late blight. This may be explained on the basis that owing to warm rains in the latter part of the season the tubers did not mature sufficiently before harvest and very slight injuries to the skin constitute, under these conditions, a fertile source of trouble in storage.

Raspberries, especially Cuthbert, suffered severely from curl and yellows. At the same time many plants showed typical mosaic symptoms with no signs of curl. There are two possibilities—the curl may be an advanced stage of mosaic, or they may be two different diseases. Symptomatically they are distinct and results of histological studies of the mosaic type agree with those in tobacco, tomato, etc. Further work is in progress on this phase.

Currants again developed the uredinal and telial stages of *Cronartium ribicola*. This has occurred for the last six years without a diseased *Pinus strobus* being found in the vicinity.

Greenhouse.—As in the field, tomatoes, especially Livingston Globe and, to a lesser extent, John Baer, suffered from mosaic. *Septoria lycopersici*, causing leaf spot, was present but was not serious.

Seedlings of *Chamaecyparis obtusa* and *Pinus Koraiensis* were damped off by a Fusarium.

Snapdragon rust (*P. antirrhini*) becaume so serious that new seed had to be obtained and all old stock discarded.

Storage.—Mention has already been made of potato losses in storage owing to unfavourable weather conditions and infection by *Fusarium spp.*

In apples black rot was fairly common, some excellent mummies with pycnidia being obtained.

Many complaints were made from the Montreal market that apples were packed so that the stalk of one apple pierced the skin of the one above. The injury was followed by infection with *Penicillium glaucum*, which rapidly caused a soft rot.

SPRAYING VS DUSTING

C. E. Petch, Dominion Entomological Laboratory, Hemmingford, Que.

Spraying and dusting orchards have been carried on generally for several years. In the case of spraying it is about forty years and of dusting about ten years. Therefore, the dusting system is working under the handicap of 30 years investigation and application. If the two systems had developed together, it is impossible to state which would be the more efficient and popular. However, we must judge between the two from the evidence at hand.

In the preparation of this paper the writer was fortunate in having before him an article by G. E. Sanders and A. Kelsall in the January issue of "Scientific Agriculture." These writers covered the subject quite thoroughly and their article will be followed fairly closely, but enlarged or criticised to suit Quebec conditions.

Dusting has many advantages over spraying, and if it were not for the severity of black rot canker in Quebec, spraying might have no advantages over dusting. In this age of high operating expenses speed is one of the main economic points to consider. Dust can certainly be applied much quicker than liquid and the writer's results have shown dusting to be three or more times as fast under similar conditions. This speed allows an application to be made at the proper time, that is during the beginning of a humid spell or at the regular spraying periods mentioned in the spray calendars.

The first year that the writer dusted, the results were excellent for the control of apple scab, in fact, better than with liquids and the applications were made during the heat of the day. However, since then, results have not been so good and it is probably due to dusting in the afternoon instead of in the morning or evening. The results of the first year indicate that dusting could be done any time during the day and good results be obtained. The advantage of the early morning and evening over the intervening period seems to have been well established by other workers. The above observations show dusting to be a time-saving method since dust is best applied during the part of the day unfavorable to most farm work ; spraying on the contrary requires the best of weather and the most important part of the day. The initial expense in purchasing a dusting outfit is about one-half that of a sprayer and the upkeep is considerably less. Sprayer parts soon become corroded and worn out, but the chemicals in a dry state have little effect upon the duster. Therefore, the cost of up keep is much less and the saving in time is also considerable, because, with a sprayer, the broken parts are always discovered when it is in use. The most important and busiest part of the spring is not time for delays and they are not

infrequent where sprayers are used. Furthermore, to replace broken sprayer parts is a difficult and tedious job, owing to the awkward position in which many of the parts are located. With dusters most of the parts are easily accessible. It is also true that the duster ready for action weighs less than a sprayer, but this is not important in the majority of Québec orchards.

The two outstanding advantages in favor of dusting are : (1) When fungous diseases develop most rapidly the weather is most suitable for dusting but not for spraying ; and, (2) the greater speed, which allows rapid treatment of large areas.

Aside from the above differences, it must be remembered that both systems must primarily be satisfactory for the control of fungous diseases, biting and sucking insects. Of the fungous diseases black rot canker and apple scab are our two most important apple diseases. As to the former, there is no evidence, to the writer's knowledge, to prove that dusting is or is not satisfactory for its control, but for the latter there is plenty of *data* to compare the two systems fairly satisfactorily.

The following figures are taken from Sanders' & Kelsall's article in Scientific Agriculture, Vol. 1, No. 1, pp. 14-18.

	Years	Unsprayed	Sprayed	Dusted
New York	4	43.2	11.4	12.2
Michigan	4	71.4	20.9	20.8
Illinois	4	70.4	19.1	19.9
Nova Scotia	4	51.4	12.4	12.4
Average of	16	56.5	15.6	15.6

The above table contains the average for four years and includes years of light and heavy scab infestation. However, since heavy infestations are the most valuable tests the following data are quoted :

Region	Year	Unsprayed	Sprayed	Dusted
New York	1913	50.6	28.5	31.4
"	1914	86.0	15.5	14.2
Michigan	1915	100.0	49.1	58.2
"	1917	99.9	14.1	10.5
"	1919	62.4	15.2	12.6
Illinois	1915	67.5	9.0	7.0
"	1916	68.4	0.9	14.7
"	1917	81.8	28.4	27.1
"	1918	67.6	37.8	30.9
Nova Scotia	1919	90.8	21.1	11.4
"	1920	51.4	29.7	40.0
Average of 11 years		75.1	22.7	23.5

The above tables show neither system to have the advantage when all the years were considered,but when only the heavy infestations are considered there is a slight difference amounting to .8 per cent in favor of spraying. At Hemmingford the following results were obtained in years of heavy infestation :

Year	Unsprayed	Sprayed	Dusted
1917	80..0	1..0	3..8
1918	95..0	..4	..4
1919	93..0	20..5	62..3

The above figures show both systems were satisfactory in 1917 and 1918 but decidedly otherwise for dusting in 1919. There were 3 days separating the 3rd application in 1919. The spraying was done on the 17th and the dusting on the afternoon of the 20th. The weather was as follows :

17th—Misty and warm.
18th—Clear and very warm.
19th—Very warm, rain at night.
20th—Cloudy, warm and muggy.

It is very probable that the scab developed very rapidly during these few days and was largely responsible for the heavy infestation of the dusted apples.

The sprays used were chiefly lime sulphur and arsenate of lead and dusts arsenate of lead and dust sulphur. However, in Nova Scotia, Bordeaux mixture was used sometimes and in Quebec arsenate of lime was used on several occasions both in sprays and dusts.

Another very important thing to consider is the injury to foliage and fruit due to burning. This has appeared more or less severely for the past four years in the sprayed areas but as yet there has been no burning from the application of dusts, which have contained as high as 15 per cent arsenate of lead or 10 per cent arsenate of calcium.

So far as biting insects are concerned all the results the writer has seen show dusted arsenicals as good, and, in most cases, better than sprayed arsenicals. In this connection the following figures on wormy apples are taken from Sanders' & Kelsalls' tables :

Place	Years	Unsprayed	Sprayed	Dusted
New York	4	22..0	7..8	5..0
Michigan	2	12..0	0..4	0..07
Illinois	4	44..7	8..8	8..5
Nova Scotia	4	6..6	3..7	2..9

The above figures are all in favor of dusting. The codling worm upon which apparently the above figures are based is only of minor importance in

Quebec, but the following figures are for insects of great economic importance here :

Variety	Year	Unsprayed	Sprayed	Dusted
Alexander	1917	99..0	10..7	11..0
Duchess	1918	100..00	3..0	2..0

Further it is very interesting to note that this year (1920) dusting for the control of the apple maggot gave better results than any spraying results ever obtained here. A mixture containing 45 per cent sulphur, 47½ per cent hydrated lime and 7½ per cent calcium arsenate, was applied on July 19th and on August 5th. The dusted trees had less than 1 per cent of the fruit attacked, but the check trees had from 50 per cent to 90 per cent of the fruit injured.

Another very important consideration in comparing these methods is their relative value in controlling sucking insects. In many fruit growing sections this would probably be the most important phase of the subject; but in Quebec it is by far the least important and hardly needs consideration. It is only rarely that aphids are present in sufficient numbers to be of economic importance and the oyster shell bark louse could probably be held in check by dusting.

One of the most difficult comparisons to make is that of cost, because present day dusts are only experimental formulae and as this part of the work is in such a rudimentary condition it is difficult to arrive at conclusions that are satisfactory. However, the following figures are based on experimental work done at Hemmingford :

1917, spraying, $16.09 ; dusting, $30.50.
1918, spraying, $23.70 ; dusting, $40.40.
1919, spraying, $27.58 ; dusting, $27.26.

The above figures for 1917 and 1918 show dusting almost twice as costly as spraying, whereas in 1919 the cost is practically the same. The cause of the great reduction in the cost of dusting was in using a mixture in which the sulphur and poison were greatly reduced and replaced by a cheap filler. If it were not for severe russetting, in some seasons, of our best varieties, Fameuse and McIntosh, Sanders' copper lime arsenic dust would be the cheapest to use, but owing to this defect it is not advisable to use it for the calyx and later applications.

The question of mixtures to suit the numerous conditions existing in various parts of the country is a broad one. So far very little information is at hand, but if the work of the past few years is continued with as much interest for the next ten years, there will probably be dusts equal to liquids for any condition which might arise.

Conclusions

1. Dusting has developed very rapidly in the past 8 years.

2. The results of experimental work in New York, Michigan, Illinois, Nova Scotia and Quebec show dusting to be as efficient as spraying in the control of apple scab and biting insects.

3. The cost of dusting in the past 2 years has been practically the same as spraying under Quebec conditions.

4. The two most important insecticides, calcium arsenate and lead arsenate may be safely used with either system.

5. Without any reliable data to hand it must be stated that dusting is inferior to spraying for the control of sucking insects. However, there is sufficient evidence at hand to cause us to believe the solution of this problem will be discovered in the next few years.

THE IMMUNIZATION OF PLANTS

G. P. McRostie, B.S.A., Ph. D.

The term immunization is used in this paper as meaning the changing of the nature of an individual plant in such a way that it is no longer susceptible to a given pathogene. The application of the principle of immunization probably offers the ideal method of disease control, but, unfortunately, our present knowledge of the best means of bringing about such a desirable condition is as yet rather unsatisfactory. In speaking of immunization in plants it is necessary for us to keep in mind that actual immunity very seldom exists in the plant world. What expresses nearer the truth and is now more commonly used is the term resistance. This latter term is used to express the ability of a plant to develop and function normally under conditions such that other plants of the same species would fail to develop or be destroyed.

The whole problem of the immunization of plants may be considered from two standpoints. First, artificial immunization obtained by introducing into the host certain chemical elements or compounds, and second, natural immunization by the isolation of resistant individuals by straight selection or by hybridization followed by selection.

Research on the first phase of this problem has been considerably stimulated by the success that has followed the use of antitoxins for the prevention of animal diseases. Many attempts to treat plants in a similar manner have been made, usually without due recognition of the totally different structure and mode of life of plants and animals. It is to be expected that due to the crudeness of the methods employed, the majority of attempts to immunize plants by artificial means have failed. The problem, however, offers an interesting and profitable field of investigation.

Efforts to immunize plants by artificial means have been conducted along two definite lines, namely—soil applications and direct injection of serums, toxin and chemicals. The first named line of attack has consisted chiefly in the application to the soil of fertilizing elements or complete commercial fertilizers or the application of copper, iron or manganese sulfates. Laurent (1), in 1899 investigated the rotting of potatoes by bacteria not normally parasitic and found that their attack was either favored or hindered by the application of different fertilizers. Pinchi (2) claimed to have decreased the severity of the attacks of grape mildew by applying copper sulfate to the soil in close proximity to the attacked vines. Marchal (3) reports being able to produce distinct resistance to mildew, in lettuce, by the addition of copper sulfate to the nutrient solution in which the plants were grown. Massee (4) was able to immunize tomatoes against leaf mold, by watering them with a weak copper sulfate solution. Norton, (5) in determining the effect of various chemicals in solution applied to the roots of tomato plants for the control of leaf diseases, obtained on the whole negative results, although a few chemicals seemed to produce added powers of resistance in the plants when inoculated with the disease producing organism.

The method of direct injection of immunizing substances has been revived in late years. Bolley (6) has made use of both nutrients and poisons to control

disease by injections of these substances into trees. Potter (7) used injections of a toxin from soft rot to inhibit the growth of the causal organism of this disease on turnips. Campbell, (8) working in Italy, claims that a wild scion grafted on a cultivated stock renders shoots from peach and apple stocks resistant to peach leaf curl and mildew respectively. Extraradicate introduction of weak solutions of tartaric, citric and malic acids rendered cultivated apples immune to mildew and to certain insects.

These few instances of reported success in artificial immunization are culled from a long list of experiments in which the results were largely negative.

Considerably more progress has been made in securing disease resistance in plants by natural means. This phase of investigation calls for the combined efforts of the plant pathologist and plant breeder. The plant pathologist must search the ranks of our different species for individuals that show more resistance than their fellows to a given pathogene. That plants of a given variety and similar in external appearances differ in their ability to resist the attacks of

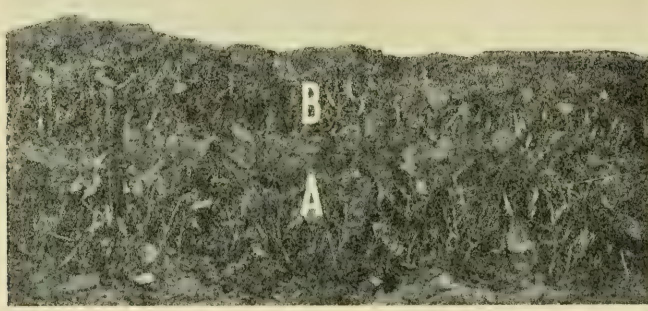

Figure 1.—Two varieties of the white pea bean varying in their resistance to bean mosaic. Row A is badly attacked by mosaic, and in consequence only a very few pods have set. Row B. is resistant to this disease and has an excellent set of pods. Row A. would only yield from two to three bushels per acre, while row B would yield from twenty to twenty-five bushels per acre.

various pathogenes is now common knowledge. Of even more importance from a practical standpoint is the fact that these variations in degree of resistance are, in most cases, definitely inherited. Plants possessing resistance to any particular pathogene can therefore be used as a starting point for the production of resistant strains.

Because of the fact that the isolation of individuals already resistant offers the easiest and least complicated method of obtaining resistant varieties or strains, it is to be expected that the majority of such varieties or strains now in existence should have originated in this manner. This accounts also for the fact that a few of our disease resistant strains have little else to recommend them. If what we desire in this connection already exists, it is obviously unnecessary to seek any farther. However, it often happens that a disease resistant plant may be undesirable in other respects either because of undesirable growth cha-

racteristics or a very limited adaptability. Under such considions, it becomes necessary for the plant breeder to make use of hybridization with other types possessing the desired qualifications, but lacking in their ability to resist the pathogene in question.

The process of producing disease resistant types by hybridization is necessarily slow because of the length of time that is required to isolate and fix the desired type from the miscellaneous population that will appear as the result of crossing. This diversity of the resulting population, while it constitutes a hindrance to rapid progress, is one of the factors in favor of the hybridization method of plant improvement in that the diverse population obtained affords a good opportunity of isolating a plant possessing the maximum of desirable qualities.

A few examples will suffice to illustrate the work that is being done, mainly by our plant pathologists, in the production of resistant strains by the isolation of resistant individuals from commercial varieties. Blinn, (9) by selection within commercial varieties, was able to isolate a cantaloupe resistant to rust. Hansen (10) has secured by selection a type of sand cherry resistant to mildew.

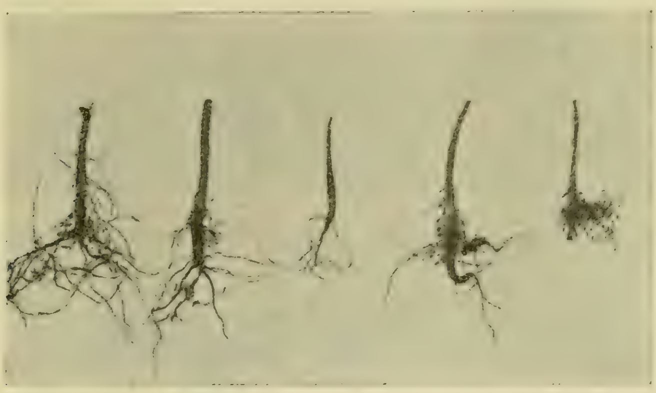

Figure 2.—The condition of the roots of four varieties of beans differing in their resistance to the dry rot organism.

Shamel and Cobey (11) obtained a strain of tobacco resistant to wilt by one year's selection. Bain *et al.* (12) selected a strain of Red Clover apparently resistant to anthracnose. Norton (13) found that the tomato varieties Stone and Stirling Castle possessed considerable resistance to the causal organism of leaf mold. Jones (14) developed a strain of cabbage possessing resistance to yellows. Barrus (15) reports a strain of beans, obtained by a grower from an individual plant selection, which is resistant to both strains of the bean anthracnose fungus.

The possibilities of the slower and more difficult method of securing disease resistant plants by means of hybridization, will be dealt with somewhat more fully. In this connection the work done in securing beans resistant to the causal

organism of bean anthracnose will be used to illustrate both the possibilities and the difficulties of this method of immunization of plants. A few illustrations from work done along this line with other crops will be included for purpose of comparison and of more fully demonstrating the possibilities of this phase of investigation. Biffen (16) and Nilsson-Ehle (17) were each able to secure a number of hybrid wheats resistant to yellow rust from the segregates of crosses between resistant wheats and those susceptible to this disease. Orton (18) obtained the wilt resistant water-melon Conqueror by crossing the citron and watermelon. Tisdale (19) was able to secure a hybrid strain of flax resistant to flax wilt by crosses between resistant and susceptible varieties.

In the case of bean anthracnose two strains of the causal organism have been isolated by Barrus, (20) and the resistance and susceptibility to these

Figure 3.—Four varieties of beans that have been inoculated with strain A. of the bean anthracnose fungus.

Figure 4.—The same four varieties (see Fig. 3) inoculated with strain B. of the bean anthracnose fungus. It is evident that variety No. 1 is resistant to both strains, variety No. 2 resistant to the A. strain but susceptible to the B. strain, variety No. 4 susceptible to the A. strain but resistant to the B. strain, while variety No. 5 is suceptible to both strains of the fungus.

strains of a large number of bean varieties demonstrated. For purposes of discussion the strains will be alluded to as Strain A. and Strain B. Unfortunately very few of our common field or garden varieties of beans are resistant to both of these strains. A considerable number, particularly of our garden beans, are susceptible to both strains of the pathogene. The remaining varieties are either susceptible to Strain A. and resistant to Strain B. or vice versa. This condition of affairs has been both a detriment and an aid in the securing of resistant types. The fact of the existence of two strains of the causal organism has decreased the chances of securing by selection individuals resistant to both of these strains. This same fact was, however, an advantage in that it presented the possibility of hybridizing a desirable variety resistant to Strain A. with a desirable variety resistant to Strain B., and isolating from the offspring strains resistant to both of these strains. This latter possibility was of particular advantage in that the two types of field beans that were resistant to both Strain A. and Strain B. each possessed the disadvantage of being a late maturing variety. One of these varieties also had a colored seed and was in addition very susceptible to bacterial blight.

A type of White Marrow bean resistant to Strain A. was crossed with a white pea bean type resistant to Strain B. The first generation plants of this cross were resistant to both strains of the fungus and the second generation, when inoculated with a mixture of both strains of the fungus, gave resistant and susceptible plants in the proportion of nine resistant to seven susceptible. One ninth of these resistant plants bred true for this character. The remaining eight-ninths when grown to the third generation and re-inoculated gave a proportion of plants that continued to breed true for resistance to both strains in subsequent generations. Of the susceptible class three-sevenths were resistant to Strain A, but susceptible to strain B., three sevenths resistant to Strain B, but susceptible to Strain A and the remaining one-seventh susceptible to both strains of the causal organism. Thus we see that by crossing the two varieties of beans mentioned it was possible to isolate not only strains resistant to, but also strains susceptible to, both strains of the anthracnose fungus, without recource to either a homozygous resistant or a homozygous susceptible variety.

The enormous losses entailed annually from diseases apparently beyond our control by artificial means as well as the labor and expense of our sprayings and seed treatments, point to the necessity of furthering as rapidly as possible natural means of control. Each year we patiently submit to losses from various diseases of our cereal and horticultural crops when such losses could be prevented by intelligent breeding of resistant varieties.

The need of the hour, then, is the closer co-operation between the plant pathologists and the plant breeders of the country, investigators with special training in pathological plant breeding, and finally sufficient moral and financial support to carry this work forward to a successful termination.

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To the Honourable J. E. Caron, M.P.P.,

Minister of Agriculture,

Quebec.

Sir :—

I have the honour to present herewith the fourteenth Annual Report of the Quebec Society for the Protection of Plants, containing the proceedings of the winter meeting of the Society, which was held at Macdonald College, Ste. Anne de Bellevue, Que., on the 24th of March, 1922.

Included are the papers that were read, and the reports of the officers of the Society.

I have the honour to be,

Sir,

Your obedient servant,

B. T. DICKSON,

Secretary-Treasurer.

Macdonald College, Quebec.

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Adams, John	C.E.F., Dept. of Agr., Ottawa.
Baillairge, V.	Forest Service, Quebec.
Baribeau, B.	Ste. Anne de la Pocatiere.
Barwick, E. C.	37 St. Antoine St., Montreal.
Beaulieu, G.	Montreal.
Bedard, Avila	Forest Service, Quebec.
Blair, R. J.	Forest Products Laboratory, Montreal.
Blair, W. Saxby	Kentville, N.S.
Bois, Henri	La Trappe, Que.
Bois, Rev. Honorius	Ste. Anne de la Pocatiere.
Bouchard, Prof. Geo	Ste. Anne de la Pocatiere.
Brittain, Prof. Wm. H	Agric. College, Truro, N.S.
Bryce, P. I.	C.E.F., Dept. of Agr., Ottawa.
Buckle, J. L.	Lyman Entomolog. Rooms, McGill Univ., Mont.
Bunting, Prof. T. G.	Macdonald College.
Caron, Omer	Dept. of Agric. Quebec, Montreal.
Chagnon, G.	P. O. Box 521, Montreal.
Charron, Dr. A. T.	St. Hyacinthe, Que.
Clayson, G. H.	17 Charron St., Montreal.
Cloutier, H.	La Trappe, Que.
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Cummings, R. F.	330, First Ave., Maisonneuve.
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Dion, J. A.	Quebec.
Doig, J.	Ste. Anne de Bellevue.
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DuPorte, Dr. E. M.	Macdonald College.
Dustan, A.	Wolfville, N. S.
Eastham, J. W.	Vernon, B. C.
Flewelling, D. B.	Fredericton, N. B.
Fontanel, Rev. Prof.	St. Mary's College, Montreal.
Fraser, Prof. W. P.	Saskatoon, Sask.
Giroux, T.	Forestry Service, Quebec.
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Gorham, A. C.	Fredericton, N. B.
Gosselin, Alfred	Ste. Anne de la Pocatiere.
Gosselin, Charles	Ft. Coulonge, Que.
Gousie, Rev. Prof.	St. Mary's College, Montreal.
Gregoire, M. L.	Forest Service, Quebec.
Guenette, L.	Forest Service, Quebec.
Gussow, H. T.	C.E.F., Dept. of Agr., Ottawa.
Hale, J. D.	Forest Products Laboratory, Montreal.
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Hall, Landon	Cowansville, Que.
Hetherington, S. J.	Dept. of Agr., Edmonton, Alberta.
Hockey, J. F.	Lab. of Plant Pathology, St. Catharines, Ont.
Honoré, Rev. Father	La Trappe, Que.
Howitt, M. H.	Macdonald College.
Hutchings, C. B.	Entomological Branch, Dept. of Agr., Ottawa.

Jack, Norman E. . . . . Chateauguay Basin, Que.
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Kieffer, H. F. . . . . Forest Service, Quebec.
Lavoie, J. H. . . . . Horticultural Bureau, Quebec.
Leopold, Rev. Father . . . . La Trappe, Que.
Levasseur, Rev. Paul . . . . Ste. Anne de la Pocatiere.
Lloyd, Prof. F. E. . . . . McGill University, Montreal.
Lochhead, Prof. W. . . . . Macdonald College.
Lods, E. A. . . . . Macdonald College.
Macaulay, R. R. . . . . Ste. Anne de Bellevue.
MacCallum, A. W. . . . . C.E.F., Dept. of Agr., Ottawa.
MacClement, Dr. W. T. . . . . Queen's University, Kingston, Ont.
Maheux, G. . . . . Provincial Entomologist, Quebec.
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McLennan, A. H. . . . . Dept. of Agr., Toronto, Ont.
McMahon, E. A. . . . . John Cowan Chemical Co., Montreal.
McOuat, J. E. . . . . Macdonald College.
McRostie, Dr. G. P. . . . . C. E. F., Ottawa
Menard, J. H. . . . . Forestry School, Berthierville.
Milne, A. R. . . . . D.S.C.R., Ste. Catharines, Ont.
Moore, G. A. . . . . 159 Querbes Ave., Outremont.
Nagant, H. . . . . 64 Maple Ave., Quebec.
Newton, Miss Dorothy . . . . Ste. Anne de Bellevue.
Nolet, Louis . . . . College de Levis, Levis, Que.
Pasquet, Jos. . . . . Ste. Anne de la Pocatiere.
Petch, C. E. . . . . Hemmingford, Que.
Petraz, Mr. . . . . Horticultural Service, Quebec.
Piché, G. C. . . . . Chief Forester, Quebec.
Reid Peter . . . . Châteauguay Basin, Que.
Rankin, Dr. W. H. . . . . St. Catharines, Ont.
Raymond, L. C. . . . . Macdonald College.
Reynaud, Mr. . . . . Berthierville, Que.
Richardson, J. K. . . . . Montreal, Que.
Roy, H. B. . . . . Sudbury, Ont.
Saunders, L. G. . . . . Cambridge University, Cambridge, Eng.
Savoie, F. N. . . . . Dept. of Agr., Quebec.
Simard, J. . . . . Dept. of Agr., Quebec.
Simmonds, P. M. . . . . Saskatoon, Sask.
Southee, G. A. . . . . 356 Durocher St., Outremont.
Stanford, Miss P. Clayton . . . . Dartmouth, N. S.
Stevenson, J. N. . . . . Gardenvale, Que.
Stohr, Rev. L. M. . . . . Ironside, Que.
Strickland, E. H. . . . . Edmonton, Alberta.
Summerby, Prof. R. . . . . Macdonald College.
Swaine, Dr. J. M. . . . . Entomological Branch, Dept. of Agr., Ottawa.
Tawse, W. J. . . . . Macdonald College.
Tessier, G. . . . . Forest Service, Quebec.
Victorien, Rev. Bro. . . . . University of Montreal, Montreal.
Willey, Dr. A. . . . . 58 Metcalfe St, Montreal.
Winn, A. F. . . . . 32 Springfield Ave., Westmount.

HONORARY MEMBERS

James W. Robertson, Esq., LL.D., C.M.G., Ottawa.
Hon. J. E. Caron, M.P.P., Minister of Agriculture, Quebec.
F. C. Harrison, D.Sc., Macdonald College.
Rev. Father Superior, Dom Pacome Gaboury, La Trappe, Que.
Auguste Dupuis, Village des Aulnaies.
Canon V. A. Huard, D.Sc., Quebec.
Rev. Father Superior, Ste. Anne de la Pocatiere.
J. C. Chapais, D.Sc., St. Denis-en-bas, Que.
A. Gibson, Esq., Dominion Entomologist, Ottawa.
Hon. Minister of Crown Lands and Forests, Quebec.

FINANCIAL STATEMENT

QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS

Receipts

Brought forward	$ 152.42	
Provincial Government Grant	250.00	
Interest on deposit	7.31	
		$ 409.73

Disbursements

Lectures and delegates	$ 56.45	
Delegates to Ont. Entom. Soc	67.60	
Delegate to Canadian Phytopath. Soc	37.60	
Delegate to Royal Society	12.50	
Secretary	50.00	
Postage and typewriting (1920-21)	24.57	
Expenses of annual meeting	19.00	
Index Generalis	6.21	
Balance on hand—May 16th	135.80	
		$ 409.73

Auditor :—

E. MELVILLE DUPORTE,

B. T. DICKSON,
Secretary-treasurer.

W. LOCHHEAD,
President.

REPORT OF THE WINTER MEETING

The fourteenth annual meeting of the Quebec Society for the Protection of Plants was held in the Biology Building of Macdonald College, on Friday, March 24th, 1922.

Business Meeting

The business meeting was opened by the President, Prof. Wm. Lochhead, at 11.00 a. m. Among those present were:—Rev. Father Leopold, Dr. F. C. Harrison, Prof. F. E. Lloyd, Dr. J. M. Swaine, Dr. B. T. Dickson, Dr. E. M. DuPorte, Dr. G. McRostie, Prof. T. G. Bunting, Dr. J. F. Snell, Mr. C. E. Petch, Mr. W. Tawse, Mr. Winn, Mr. F. H. Grindley, Mr. Coderre, Mr. Blair, Mr. Howitt, Mr. W. N. Keenan, Mr. A. G. Dustan, Mr. T. G. Major, Miss D. Newton, Mr. J. K. Richardson, Mr. Dunn, Mr. Lachaine, Mr. Shepherd, Mr. Gordon, Mr. Hale, and others.

The minutes of the last meeting were approved.

The report of the treasurer was read and accepted.

The following were the officers appointed for the following year :—

President:—Prof. Wm. Lochhead, Macdonald College.
Vice-President—Rev. Fr. Leopold, La Trappe.
Secretary-treasurer:—Dr. B. T. Dickson, Macdonald College.
Directors:—C. E. Petch, Esq., Hemmingford, Que.
Prof. G. R. Cossette, La Trappe.
A. F. Winn, Esq., Montreal.
Rev. Prof. Fontanel, Montreal.
G. Maheux, Esq., Provincial Entomologist, Quebec.
G. Chagnon, Esq., Montreal.
G. Bouchard, M.P., Ste-Anne-de-la-Pocatière.
Dr. A. T. Charron, St-Hyacinthe.
Auditor:—Dr. E. Melville DuPorte, Macdonald College.
Delegate to the Royal Society of Canada:—Prof. W. Lochhead.
Delegates to the Ontario Entomological Society:—Prof. W. Lochhead and Rev. Fr. Leopold.
Delegates to the Canadian Branch of the American Phytopathological Society:—Dr. B. T. Dickson and Prof. Cossette.

It was resolved that the Society, so far as funds are available, continue to help in aiding investigations concerning economic diseases caused by insects fungi, or bacteria.

It was resolved that letters of condolence be written to the relatives of the following members, deceased during the year, whose absence will be felt by the Society:—Rev. Dr. Robert Campbell, Rev. Dr. Thos Fyles, and Mr. L. Gibb.

It was unanimously resolved that Dr. J. C. Chapais, Mr. A. Gibson, and Abbé Dom Gaboury be made Honorary Members of the Society.

The continued increasing demand for copies of the Report of the Society from other Societies, Universities, Colleges, Experiment Stations, etc., was reported by the Secretary and was considered very satisfactory. It was explained that the type of article in the Report was intended to suit as far as possible the needs of a wide reading public.

It was decided to postpone the summer meeting until December, in order to meet in conjunction with the Canadian Branch of the American Phytopathological Society, which is holding its annual meeting at Macdonald College.

GENERAL SESSION

The general session of the fourteenth annual meeting was opened at 2.00 p. m. by the President, Prof. W. Lochhead. The addresses and papers are printed in detail in the body of the Report. The guests of the Society were Dr. C. D. Howe, Dean of the Forestry School of Toronto University, and Dr. J. H. Faull, Head of the Department of Botany of Toronto University.

Dr. F. C. Harrison, Principal of Macdonald College, extended a cordial welcome to the delegates and members and especially welcomed our guests from Toronto University.

THE PRESIDENT'S ADDRESS

SOME EARLY FOREST ENTOMOLOGISTS

By W. Lochhead, Macdonald College

Ladies and Gentlemen :—

This is the fourteenth annual meeting of the Quebec Society for the Protection of Plants. Organized in 1908, this Society has endeavored to foster the investigation of those insect and fungous agents that hinder the development of plant life and to make available to all persons interested in the preservation of plants, whether they be forest or shade trees, or field and garden crops, reliable information regarding the best methods of treatment in the form of an Annual Report. The membership has never been a large one, but it is thoroughly representative of both the French-speaking and the English-speaking peoples of the Province.

In the fourteen years of the society's existence, several members have been lost by reason of removal to other provinces, and several have been lost by death. The death of Dr. Gordon Hewitt, Dominion Entomologist, in Feb. 1920, was a severe blow, and the recent deaths of Dr. Robert Campbell,

of Montreal, and Dr. Thomas W. Fyles, of Ottawa, in 1921, remove two charter members and active workers whom the society can ill afford to lose. Still more recently we have to lament the death of Mr. Lachlan Gibb, of Montreal and London, England, who found time, during his occasional visits to Montreal, to attend our annual meetings.

As the papers and discussions at most of our meetings have been largely devoted to the consideration of the enemies of field, orchard and garden crops, the Executive Committee considered it advisable to put on a programme this year that would make a special feature of forest and shade trees. No one nowadays questions the importance of our forests as a great natural resource, but the truth has been forced upon us in recent years that this supposedly illimitable forest supply is becoming perilously endangered and that it is only a matter of a few years before the forest areas will fail to supply the demand upon them unless strenuous measures be taken quickly to control reckless cutting, the insect and fungous enemies and fire and to initiate a vigorous policy of replanting. These matters will be dealt with at length by the speakers whose names appear on the programme, and there is no need for me to say more along this line at this time.

This is my fourteenth Presidential Address, and I have attempted in every address to discuss some topic of general interest to the members of the Society. This time I shall take the liberty of presenting a few notes on the forests entomologists who have made large contributions to the science of forest entomology—the men who laid the foundations of our knowledge of forest insects.

We must look to Europe for the first investigations into the life and habits of forest insects, for there first was felt the need for action looking toward the conservation of forests.

These investigations do not date very far back—in fact less than a hundred years. The most prominent workers were Kollar, Ratzeburg, Eichhoff, Kaltenbach, Perris, Nordlinger, Henschel, Taschenberg and Judeich and Nitsche. In Germany and France, Forestry Schools were established early and in all of these forest entomology was studied.

In any consideration of the investigators of insects affecting trees, we have to distinguish between those men who were mostly systematists and those who devoted most of their studies to the life and habits of the insects. The former group contains a larger number of workers than the latter. To such belong *Linnaeus* (1707-1778) who gave us the system of binomial nomenclature, and was perhaps the greatest among systematists. *Fabricius* (1748-1808) a Dane, was also a great systematist and described a large number of forest insects. *Réaumur* of France (1683-1757) and *DeGeer* (1720-1778) of Sweden, combined a study of life and habits of insects with that of description, and both left important works which belong to the great classics of entomology. The Englishmen *Kirby, Leach* and *McLeary*; the Frenchmen *Guenée, Latreille, Bonnet* and *Olivier*;

the Germans *Zimmerman* and *Gyllenhal*: and the Americans, *Say*, *Harris*, *Fitch*, *LeConte*, *Walsh*, *Packard*, *Riley* and others have all described many species of insects infesting trees.

In the second and smaller group of forest entomologists, the earliest were J.M. Bechstein and G. L. Scharfenberg who published in 1804-1805 a "Complete History of the Harmful and Useful Forest Insects". In 1818 Bechstein published a revised edition of this work. E. Thiersch published in 1830 a work on Forest Beetles, with special reference to the Bark Beetles. V. Kollar published in 1837 a Natural History of the Injurious Insects in Agriculture and Forestry, which is still consulted. The greatest name in the list, however, is that of Ratzeburg who laid the foundation of forest entomology upon which all succeeding workers have built. His works are classic masterpieces.

LIFE OF RATZEBURG

Julius Theodor Ratzeburg was born in 1801 at Berlin. As a boy he received instruction in Botany from his father, a professor in the Veterinary School. Owing to the death of his father in 1808 and the remarriage of his mother, he went at the age of 12 to live with his uncle Wutzke at Koenigsberg where he attended Frederick College for a time. Later he attended the Lyceum in Posen and the "Gray Cloister" Gymnasium in Berlin. Even in his school days he showed great aptitude for drawing. His inclination to Natural Science was shown in his sudden resolve at this time to become an apothecary, and as an apprentice he served in the Laboratory of Wendland in Berlin. His spare time was utilized in various scientific researches in the large Berlin Gardens. This sort of work was unsatisfactory for he saw that an essential part of Natural Science was Zoology and Anatomy to which he was a stranger. Consequently, in 1821, he enrolled as a student in medicine at Berlin. He took his degree in 1825, obtained permission to practise his profession in 1826, but he did not care to practise, so he remained at the University.

Ratzeburg had the good fortune to come into close touch with many important persons of the day. His student companions Brandt, Goeppert and Phoebus remained his life long friends, and as a private teacher he became acquainted with the Humboldt family. When the new Forest Academy of Neustadt-Eberswalde was opened in 1830, he was appointed to the chair of Natural science, which onerous position he held for nearly 40 years. At the outset Ratzeburg recognized clearly that the Natural Sciences should be taught from the standpoint of forestry, and he guided his instruction accordingly. He emphasized Entomology rather than Botany, for he saw clearly the great economic value of the study of forest insects, and the corresponding need for more detailed knowledge of these enemies.

To the study he devoted himself unselfishly and untiringly. In 1832, he wrote "The Development of Foot-less Hymenopteran Larvae", and in 1834 "Entomological Contributions". In 1835 he began his most important literary

work: "Forest Insects"—Part I, appearing in 1837, Part II, in 1840, and Part III, in 1845. This great work was the result of ten years of uninterrupted study of many widely-scattered notes on forest insects and of ten years of personal and correspondence touch with foresters, forest people and forest insects.

In the years 1844, 1848 and 1852 appeared "The Ichneumons of Forest Insects" in three Volumes, perhaps the best known of Ratzeburg's works—especially to entomologists.

Realizing that his "Forest Insects" would be too expensive for the average library and student, Ratzeburg had prepared a smaller book—"Forest Destroyers and Their Enemies". This book was published in 1841 and had reached its 6th edition in 1869.

Ratzeburg's plan was to investigate not only all injuries to trees by insects, but those resulting from physiological and pathological causes. To this end, he published in 1862 "The Diseases and Reproduction of the Pine as a Result of the Attack of the *Trachea piniperda*, the Forl-Eule", but he soon realized that it was impossible for any one man to deal adequately with the Physiology and Pathology on account of the rapid advances that were being made in these sciences at that time.

In 1866 he published Part I of a magnificent work entitled "Forest Injury or Losses inflicted by Insect Attacks, etc." Part, II, appearing in 1868.

In May 1869, after 39 years of most useful, unselfish activity as a teacher, Ratzeburg took a well-earned rest; moreover, his health rendered such a proceeding necessary. Already he had begun another work entitled "A Forestry Lexicon for Authors", and the manuscript was ready for the press at the time of his death in October 1871. This work appeared in 1872.

Beside the list of publications that have been mentioned, Ratzeburg published several smaller works on allied botanical and zoological subjects.

In the words of Phoebus, his life-long friend, "he erected a Dankmal, a monument more lasting than brass". It is not exceeding the truth to say that Ratzeburg's work stands as the greatest single contribution to forest entomology. Judeich and Nitsche's work on Forest Insects is a revision of Ratzeburg's great work, just as Escherich's work is a revision of Judeich and Nitsche's.

Parasitic Insects

According to Professor Trotter, the first person to divine the importance of parasites and predaceous insects and to apply the principle successfully was Boisgiraud of Poitiers, in France. About 1840, he freed the poplars in the suburbs of his town of Gypsy Moth by placing the *Calosoma sycophanta*, and he destroyed forficulids in his own garden by using *Staphylinus oleus*.

These successes seem to have inspired the Milanese to offer a medal to be given in 1845 to any person who had in the meantime conducted successful experiments in the artificial breeding of carnivorous insects which may be

used advantageously to destroy insects injurious to agriculture. To this appeal Antonio Villa responded in 1844 with a pamphlet entitled "Carnivorous Insects Used to Destroy Species Injurious to Agriculture", in which were set forth at length the results of successful experiments carried on by him at Desio, in the province of Milan. In these experiments carabids and staphylinids were used. Villa's results were criticized by Bassi, Bellani and Ratzeburg. The latter said:—"Carnivorous insects can be applied to the needs of agriculture only by the beneficient hand of nature and every effort to assist it must be in vain!"

In 1850 Rondani, an Italian, began his important researches on insect parasites and published a work entitled "An account of Parasitic Insects and Their Victims". He was of the opinion that parasites are of greater value than birds in the control of insects.

Perris, of France, published an important monograph in 1857: "The History of the Insects of the Maritime Pine". He noted the importance of parasitic and predacious insects in the destruction of wood-eating and leaf-eating forms.

DeCaux, also of France, about 1872, did much valuable work on the utilization of parasites in the fight against injurious insects.

E. L. Taschenberg published in 1866 a valuable work on The Hymenoptera of Germany, in 1874 a work on The Natural History of Insects Injurious to German Forests, and in 1880 a work on Practical Entomology.

G. Henschel published in 1861 and 1876 a "Guide to the Determination of Injurious Forest Insects, with information as to their life history and means of control".

J. H. Kaltenbach published in 1874 a "Handbook of Insects for the Use of Agriculturists, Gardeners and Foresters".

To Eichhoff we are indebted for an excellent work on European Bark Beetles (1881). He not only described many forms but discusses the bionomics of the group. He said that "the most favorable conditions for the increase of these beetles are doubtless a warm early spring and a warm summer with frequent rains and a long mild autumn". Other contributing factors are strong winds, snow, frosts, forest fires, the devastation brought by caterpillars, whereby the trees are more or less decorticated in places and otherwise wounded (Packard)".

For many years, the only work of importance on Forest Insects published in America was that of Packard, published in 1886-1890.

In 1905-1906 Dr. E. P. Felt published a valuable work in two volumes on "The Insects Affecting Park and Wood land Trees". The work of Doctor Hopkins in the United States and Dr. Swaine in Canada is of tremendous value, but this cannot be treated at this time.

FOREST PATHOLOGY IN RELATION TO FOREST CONSERVATION

By Dr. J. H. Faull, Toronto, Univ.

The forests of Canada have been a notable heritage, a wide-extended covering of magnificent trees of many kinds; they have provided a shelter for game and fur-bearing animals, a protection for the watersheds, playgrounds for the people, an unending storehouse of wealth and a continuous and unmeasurable source of spiritual power. For the main part they have remained in the ownership of the people, the state; thus it is that their conservation is of direct interest to and a responsibility of every citizen of the country.

Three agencies have been very active in destroying this heritage—waste, fire, and disease, and with such effect that there is a very real danger of an

Fig. 1.—Scene in a Quebec pulpwood forest after harvesting. This area has been severely damaged by the spruce budworm and the timber-destroying fungi that follow the spruce budworm.—(Photograph by courtesy of O. Schierbeck.)

asset being converted into a liability. Conservationists have been prophesying for many years the approaching exhaustion of our forests. There has been a tendency to call their assertions into question, or at best to accept them with a mental reservation; the conditions we now face are a complete vindication of their gravest warnings. We are all too familiar with endless barren wastes once clothed with forests and with the increasing remoteness of profitable timber; but few even yet realize that over vast stretches the pines have become almost literally, certainly practically extinct, that the spruces are rapidly

disappearing in the same way, and that the once despised balsam is most seriously threatened; yet such is the case.

The gravity of the situation is now impelling attention along two lines of action, namely *utilization* and *restoration*, the making best use of what remains, and the re-establishing of a forest cover over the despoiled wastes, or, in brief, the adoption of purposeful and beneficial systems of forest management. Happily the fundamental necessity of *protection* has already been recognized and is being practised; so the way has been prepared for the formulation of policies of regulation.

The ideal regulated forest is a healthy forest; we are starting towards that ideal with extremely decrepit forests. The undisturbed virgin forests in the aggregate probably exhibit a balance between disease and accretion, but through the interference of man, the stronger healthier trees of our forests in general have been removed, sanitation has been neglected, and as a result, the normal tone has been distintly lowered. Therefore it is not surprising to discover that a large proportion of the problems of the transition period which we anticipate will culminate in regulated forests are problems of forest pathology. Many of them are of fundamental importançe in relation to fire protection, utilization, productivity, stumpage values and type successions.

The role of forest pathology in the planted forests of Europe is clearly defined; European foresters remove weak and infected trees from their plantations, and the rangers are taught to recognize and instructed to destroy the fructifications of disease-producing fungi. Campaigns against specific fungi have at times been organized and carried through successfully. The case is similar with regard to nurseries, parks and street trees; in such locations spraying can be profitably adopted and even individual trees can be medicated or placed under the surgeon's saw and chisel.

But it is very different with our great untamed American forests. It is plain that the methods applicable to plantations and nurseries are unsuited to them; their problems, often complicated, demand separate and special consideration. By way of concrete examples of representative problems solved or under investigation, let me cite three types drawn from work in Ontario—(*a*) the needle blight of the white pine, a special problem with reference to a cutting policy, (*b*) a study of the heart rot of birch, a problem relating to the utilization of this wood for purposes demanding maximum strength and (*c*) studies on butt and heart rots, a complex of problems affecting almost evey phase of forest management.

(*a*) **Needle blight of the white pine.**

Among the special problems that have been called into review in Ontario, particular attention has been given to the needle blight of the white pine. This malady is especially prevalent in some of the white pine stands of northern Ontario, and though perhaps not so frequent elsewhere, may be found to occur in any part of the Province. An investigation was undertaken in 1918 and

continued in subsequent summers at the request of the Forestry Branch of Ontario for the purpose of determining its nature (especially whether or not it be contagious) and its effects on pine stands suffering from its attacks. The existence of this disease appears to have been reported to the Branch for the

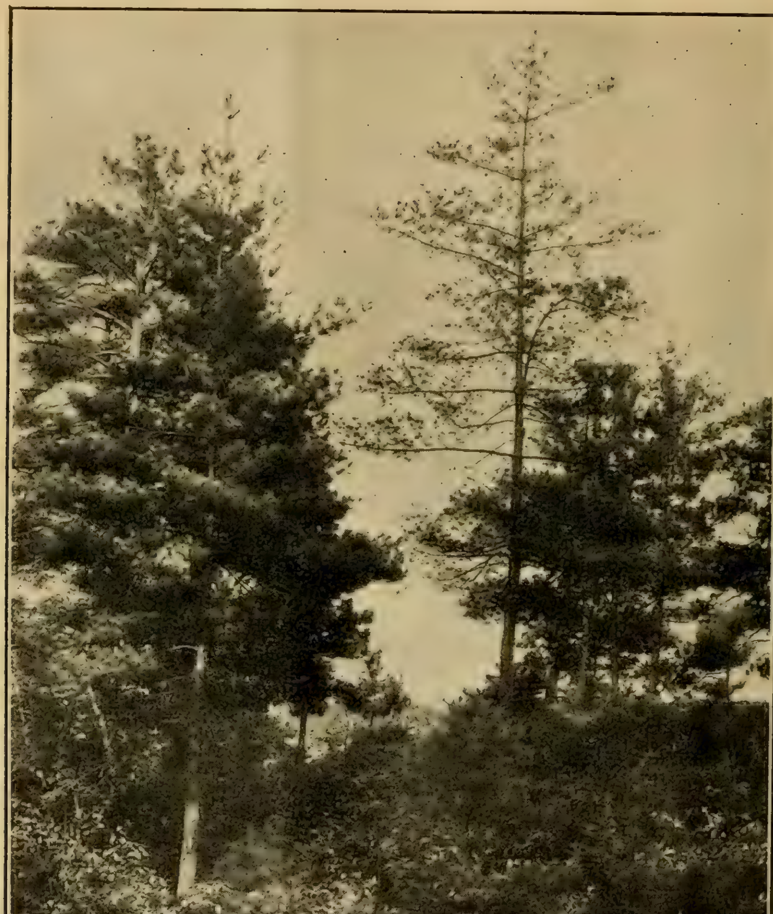

Fig. 2.—A severely and repeatedly needle-blighted white pine at the right; a healthy white pine at the left.

first time from the Timagami Forest Reserve in 1905, and again from the same area in 1908, 1912, 1913 and 1917. Mr. C. E. Hindson, Chief Ranger of the Timagami Forest Reserve, wrote in August, 1912, stating that "a large number of pine trees in the vicinity of Timagami Lake have turned brown and appear to be dying." The greater part of the research has been carried out in Timagami, an area located about 300 miles north of Lake Ontario.

The most striking of the symptoms of blight consist of a yellowing or reddening of the new partly-grown needles very shortly following their emergence from the buds, an event that occurs in late June or the first part of July. The discoloration continues progressively from the tips of affected needles downwards over an interval of about two weeks. The upper part of the tree is usually most severely affected although all parts are commonly involved. The extent of the blighting is most frequently uniform for all needles of any single fascicle, and shows itself in varying degrees up to totality.

It was soon ascertained that the injury was not a winter killing of the foliage, an enzymatic disease, or due to fungi or insects, nor could it be induced in healthy branches by fusing them at freshly abraded spots with diseased branches of affected trees. It was discovered in 1919 that the trouble lay in the roots, that the absorbing roots were largely dead in blighted trees, as a result of which, at the time the new needless are expanding there is a sudden demand for a greatly increased supply of water which cannot be delivered. Consequently the young needles turn pale and then redden from the tips downwards. The foliage of trees recovering from blight in later years may be short, tufted and pale, but there are other factors to be considered in that connection. The cause of the killing of the absorbing roots has not been fully demonstrated, but there is evidence to show that it may be brought about by a drying out that takes place in periods of drought in shallow or leachy soils. Owing to the dry weather experienced in the summer of 1921, the blight, while not as abundant in Timagami as in 1918, was more sharply defined than in 1920.

But white pine (*Pinus strobus*) is not the only tree affected in the blight areas, although it probably suffers much more severely than other types; proof is accumulating that shows that other timber species are involved to a greater or less extent, depending on their relative susceptibilities.

The question of needle blight has come into consideration in relation to another problem, namely, the possibility of distinguishing between needle blight and discolorations due to sulphur fumes in areas within the possible range of sulphur dioxide emanations. They can be differentiated during the growing season, but probably not at any other time. Observations on both phenomena have shown that burning of the leaves from sulphur fumes takes place rapidly and whenever conditions of temperature and humidity are favorable, and the injuries are not necessarily restricted to the needles of the current season, although these are the ones that are most susceptible. As has been seen, needle blight occurs at a definite period in relation to the emergence of the needles from the buds. In the early spring, that is, before the buds break, it is doubtful if it be always possible to distinguish with certainty needle blight from winter browning or from injuries due to sulphur fumes.

Observations on the needle blight have now been carried on for four years, and the status of 633 white pine trees whose histories have been followed since 1918 is summarized in the table that follows.

Blighted trees studied	358
Checks (healthy trees)	275

Of the checks two only have developed blight and under known conditions. They blighted in 1919 following partial lifting of the thin soil cover and its permanent displacement from the bed of coarse broken rock on which it lies —the action of ice. These trees died in 1921. The blighted trees have been divided into two classes; (1) Those with trunks 6 inches or less in diameter, b.h. (II) Those with trunks more than 6 inches in diameter.

Blighted in 1918		Died			Total per cent dead	Showing blight in 1921	Apparently recovered	Doubtful
		1919	1920	1921				
I	147	2	6	2	6.8	24	105	8
II	211	12	20	18	23.7	80	44	37

From the results obtained it is reasonable to conclude (1) that young stands are not likely to be seriously depleted by needle blight; (2) that injury to heavily blighted mature stands may be so great as to be a deciding factor in determining the time of harvesting; (3) that in regions subjected to sulphur fumes, it is possible to differentiate between blight and sulphur fume injury if the examination be made at the right time; (4) that the malady is not contagious and hence is solely of regional importance.

(b) **A heart rot of birch.** (*Fig. 3*).

A special case calling for an investigation of the heartwood of birch, normal in appearance but weakened from some unknown cause, was undertaken some months ago because of complaints of manufacturers using this wood for spokes and other purposes demanding maximum strength. A preliminary examination showed that this was due to a common fungus the relationship of which had not heretofore been worked out, namely the true tinder fungus, and that wood for the purposes mentioned should not be taken from certain types of defective trees easily recognizable in the forest.

The true tinder fungus attacks standing or fallen beech, birch, poplar and occasionally elm, causing a whitish decay. It is readily recognized by its fruiting-bodies or sporophores, the grayish hoof-shaped punks or brackets so common on the trunks of its hosts. Most frequently this fungus works from the crown down, though not invariably so. The true tinder fungus abounds throughout Ontario, and is also frequent in the adjoining states. Von Schrenk & Spaulding (Von Schrenk, H. & Perley Spaulding: Diseases of Deciduous Forest Trees,

Bull. No. 149, Bureau of Plant Industry, U.S. Dept. of Agr., Washington, 1909) report that "In northern New-England, New York, Michgan, Wisconsin and Minnesota in particular, the tinder fungus (*Fomes fomentarius*) is one of the commonest wood-destroying forms found in deciduous forests."

Botanically many new points of interest have been noted—such as the characters of its spores, their viability and method of germination, the remark-

FIG. 3.—*Fomes fomentarius* on trunk of a living yellow birch.

able habit of vernal spore discharge, and the production of spores for three or four years from the same pore layers. But the main interest here centers on the relationship to its host. Regarding this feature, a general misconception has existed and one that directly concerns the application of the heartwood to some industrial purposes. Various manuals or bulletins dealing with the fungus ascribe to it a decay in the outer sapwood of living trees immediately

under the bark, from there working inwards. An examination of hundreds of affected trees has failed to substantiate this view in any one instance. On the contrary, in living trees the fungus enters through wounds or broken or dead stubs and penetrates to the inner sapwood and heartwood, rapidly spreading up and down in these regions of the stem and more slowly outward towards the bark. In birch it appears to spread more abundantly and rapidly in the inner sapwood, but it is important to note that the adjoining heartwood is also affected and in consequence weakened. One of the most significant features is the circumstance that cured timber from trees in which the decay is in its

Fig. 4.—A section of yellow birch attacked by *Fomes fomentarius*. The section was placed for some days in a moist chamber. A strong development of the mycelium, which darkened in time, appeared as indicated in the blackened zone of the photograph.

incipient stages is indistinguishable by ordinary means of examination at the command of the user, from perfectly sound timber. The infection of the birch appears to be commonly associated with the breaking of the branches of the crown due to the action of a boring insect. (*Fig. 4*).

(*c*) **Butt and heart rots.**

Butt and heart rots constitute the outstanding destructive agencies at work in our forests. No forest is exempt, and every mature stand becomes more and more susceptible with increasing age. The time inevitably comes when they bring about an accelerated loss of stumpage values through deterioration. They are also responsible for most wind-falls and consequently for

the vast amount of debris that litter the floors of our forests, affording a limitless supply of highly combustible waste material, and finally butt and heart rots are dominant influences in relation to the succession of cover types in unregulated forests. Fortunately they are almost altogether restricted to mature or suppressed timber; young trees are practically immune. This fact greatly simplifies the problems of control and gives assurance that they will be largely solved in the administration of any good policy of forest management.

One of the unexpected drawbacks encountered in investigating butt and heart rots has been the lack of information on even the identity of the causal

FIG. 5.—A common scene in an over-mature forest. Both the red pine and the balsam at the lower right were severely butt-rotted. Not infrequently a large proportion of the affected trees in such areas are brought to the ground by the wind or their own weight.

organisms. Balsam rots may be cited as an extreme case; though several types occur in living balsam trees, nobody as yet, so far as the literature shows, has definitely established a connection with a specific causal factor in any single case. To help meet this situation investigations were begun two years ago, and are now being carried on with fruitful results. The methods employed include those so successfully used in cultural diagnostic studies of bacteria.

But there are other fundamental problems of even greater importance calling for solution, such, for example, as the rate of progress of heart and butt

rot infestations, the relations of these diseases to the age of the host species, to the specific resistance of the host and to environmental factors. And here we would include such topics as soil characters, crowding, mixed stands and climate, all of which have a direct bearing on the relation of heart and butt diseases to yield and hence to the questions of reforestation and harvesting.

Such experimentation moves slowly. True, but it will be readily conceded that the exploitation and neglect of half a century cannot be repaired in a day. The solution of the problems of our unregulated and unscientifically treated forests will demand time, patience and a force of trained investigators. But every problem solved will be of value in the administration of and will contribute to the welfare of the forests of to-day and to-morrow.

OUR FOREST CONDITIONS AND SOME OF OUR FORESTRY PROBLEMS

By Dr. C. D. Howe, Toronto University.

A detached observer, looking upon the affairs of men, would note the occurrence of definite periods of confidence and fear, boastfulness and humility, periods of enthusiasm and high endeavor, periods of depression and futility. These periods recur quite regularly in cycles; they recur in cycles in the individual's life and in the nation's life. The causes are not well understood: they may be environmental or they may be psychological or both. Too often, they may be chiefly psychological. Since the psychology of the industries is largely the psychology of the people concerned in them, they, too, exhibit cycles of buoyancy and flaccidity, of prosperity and poverty, cycles of aggressiveness and timidity.

With these general observations in mind, let us turn to our wood-using industries, or rather the sources of supply of raw materials for those industries, the forests, and inquire through what periods the attitude of the people, the national psychology, has passed with regard to them.

In the first place, we are all familiar with the fact that the forests must give way to agriculture. In the early days, the pioneer and the forest were enemies because, at that time, the settler could not get the necessities of life from the forest, but the products of the farm were entirely sufficient for his simple wants. The quickest and easiest way to get rid of the forest was to burn it. What a story it has been! What a record of achievement! When one beholds the wide rolling uplands of Ontario, the fertile meadows of the St. Lawrence valley, and the green fields in the provinces down by the sea, he is lost in admiration for the sturdy pioneer who destroyed the forest to create the farm. You know ours is a vast country with a small population and, therefore, we are still in the pioneering stage. Within less than 100 miles of Montreal one still finds the settler clearing the forest to make a farm. Within

a few hours by rail from any of the large cities of Canada, one may find the pioneering development of farms and mines on a large scale. Forest conditions have changed. The value of the forest has increased enormously in the past 100 years, but unfortunately the mental attitude of the pioneer has not materially changed. A large percentage of the destructive forest fires in Eastern Canada are caused by the carelessness of the settler and prospector. If we include those chargeable to the pioneer railways, then we may say that much the greater portion of the forest devastation is attributable to the pioneer spirit. Our forests suffer grievously from the inertia of a fixed idea.

During the early eighties a remarkable wave of enthusiasm for forest conservation swept over Canada and the United States. It took the form of fire protection legislation, tree planting on arbor days, and the establishment of forest plantations. Among the leaders of the movement in Quebec were Sir Henri Joly de Lotbinière and Mr. William Little, whose names public spirited people still revere. At this period there was much discussion of the approaching exhaustion of the timber supply. One writer lamented the fact that the pine logs in the drives would yield deal boards only two feet wide compared with the logs of previous years that would square from two to three feet. Mark the dimensions, those of you who have seen the log drives of recent years! A prominent lumberman predicted that the supply of pine in Quebec would not last more than 25 years. Over 60 million feet were cut in the Province in 1920, which shows there is still some pine left. Yet the lumberman was right. Using the standard of his time, his prediction came true. Forty years ago only the largest and finest trees were taken. It apparently never occurred to thim that it would ever be profitable to use trees less than two feet in diameter. He couldn't have imagined the use of small pine logs for laths and matches.

During the next period the pendulum of public opinion with regard to the forest resources swung far in the other direction. It was a time of great industrial development and of increasing prosperity. Owing to increasing demand, timber values mounted rapidly. Fortunes were made in timberlands, more often, however, by the speculator than by the actual operator. Yet great business organizations were built up by sagacious and public spirited men. Their achievements stand high in the annals of Canadian industries. Quite naturally, however, there developed a feeling of over confidence with considerable expansion in the thoracic region. Our forests are illimitable and their supplies inexhaustible. Why worry? All talk of the necessity of husbanding the forest resources is the blank-edest nonsense. It was an unpopular thing to say ought to the contrary. Indeed, some of the prominent conservationists of the time were publicly accused of being unpatriotic and of attempting to check the industrial development of the country. Unfortunately, some of these unfounded conceptions have persisted down to the present time, having been kept alive by the unthinking but loquacious politicians on the hustings and having been perpetuated even in school textbooks. Let me say,

again, that our forest resources have suffered grievously and in the future will suffer still more grievously from the inertia of a fixed idea.

Gradually the reaction from the feeling of over-confidence with regard to forest supplies set in. The hinterlands were being explored and the notion that they were densely forested was exploded. The effect of the awful devastation by forest fires on future supplies was slowly soaking into the public conscience. This feeling of uncertainty as to the future was common to Canada and the United States and it culminated in the establishment of Commissions of Conservation in both countries in 1908 to 1909.

The Commission in the United States was established before that in Canada, but ours lived longer, being strangled to death only last year. The leaders in the United States were such men as the then President Roosevelt, Gifford Pinchot, Judge Taft, and in Canada, the then Premier Sir Wilfrid Laurier, Sir Clifford Sifton and the late Senator Edwards. The period was characterized by a stock-taking of all resources—a very simple and fundamental idea, the first step in any private business organization, but one that, for some obscure reason, always meets with opposition, especially from politicians, when applied to public organizations. We shall never know what it is necessary to do for our forests, for example, until we know what we possess in terms of present capital stock and its rate of natural accretion in relation to the present and probable future harvests of timber and pulpwood. The late Commission of Conservation was the only organization that ever attempted such investigations on a Dominion wide basis—and it was cut down in the dark before its work was completed.

After the Great War we were very humble, but at the same time very proud of the Empire's achievements. We are finding out by sad experience in our industrial and social relations that some of the most important results of the war were not the most obvious at the time of its cessation. Among other things the war taught us the value of the Empire's forests and, as you know, the Canadian Forestry Corps was a very important factor in winning the war. The importance of the forest as an auxiliary unit in warfare led Great Britain to establish a Forestry Sub-Committee as a part of its great Reconstruction Committee that did such magnificent work in meeting the changed requirements of peace. The Forestry Committee reported upon the forest conditions in all parts of the Empire and formulated plans for a great reforestation program, involving the planting of 1,700,000 acres and the expenditure of $75,000,000. In the case of Canada, after pointing out the dependence of Great Britain upon the forests of the Dominions, especially those of Canada, describing the efforts of the various forestry organizations, and urging the extending and the speeding up of their work, the Committee makes this statement: "The forest capital of Canada is growing less year by year. This, we submit, is an Imperial question of first magnitude which deserves immediate attention of the Imperial and Dominion Governments." As the result of the recommendations of this Committee, an Imperial Forestry Conference was

held in Great Britain in the summer of 1920. Six delegates attended from Canada, Quebec's representatives being Ellwood Wilson, Chief Forester to the Laurentide Company, and Mr. Bedard, Assistant Chief Forester to the Quebec Government. Among other things, the Conference recommended complete surveys of forest resources in the various dominions and the gathering of data on the rate of growth and regeneration. It stated that such data were absolutely essential to rational and economic management of the forests.

The Imperial Forestry Conference marks another period in the history of our forest treatment. The direct interest of the Empire in how we manage our forests; that is a very significant thing, capable, if sustained, of far-reaching consequences to the advantage of the forests and consequently to Canadian industries.

The characteristics of the present period developed gradually, however. The war had an accelerating effect and linked Canada up with the Imperial forestry needs. The beginnings of the present period were indicated some years ago in the management of extensive forest areas in the West by the Dominion Forestry Branch, in the employment of foresters by lumbermen and pulpwood companies, and in the development of reforestation programs. The Province of Quebec took the lead in the two latter. The first private companies to employ foresters are here. The first companies to begin planting operations on a commercial scale are in this Province. The Provincial Forester was perfecting his plans for cooperative planting on pulpwood limits before the Imperial Conference took place. I am informed that certain pulpwood companies are making the necessary investigation of reproduction and rate of growth preliminary to restricting the annual cut to the amount accumulated by the annual growth. Similar studies are being made in New Brunswick. Within the past few weeks, the Prime Minister of Ontario has announced his adherence to a reforestation program that calls for the planting of 10,000 acres a year for the next sixty years.

Now, why is it that private companies are going into the business of forest planting on a large scale? Why is it that Ontario is planning to reforest over a half million acres of waste lands? Why did the British Reconstruction Committee say that forest conditions in Canada presented an Imperial question of first magnitude which deserves the *immediate* attention of the Imperial and Dominion Governments? Let us hastily examine into our forest conditions to see if we can find a satisfactory answer to these questions. Before we proceed, however, let me point out a mistaken conception quite generally held by the public. People think that, if an area is covered with a forest of some kind, all is well. In our climate, they say, nature will always give us trees of a sort. Let us take what nature gives and not worry about the future. This assumes that all trees are so alike in their physical and mechanical properties that they can all be used, if necessity requires, for the same purpose. Any farmer or wood-user knows this isn't so, yet I have often heard the idea expressed by otherwise intelligent people who ought to know better. Quite

likely they talk that way because of the emolient properties of the idea. As a matter of fact, there are forests and forests; there are trees and trees. It does not follow that an area covered with forests is commercially valuable because of their presence, or that one tree is as good as another for the various purposes of the market. In the neighborhood of 70 different kinds of trees have been used in this country in the wood and timber trade, but a very few species contribute the greater portion of the output. About four billion feet of lumber are cut in Canada every year. Their value as rough lumber is approximately $122,000,000. When time, labor and thought have been expended upon them they become worth around $250,000,000. Thus our forests, in terms of the manufactured lumber products, increase our national wealth a quarter of a billion dollars each year. Over two-thirds of the above values are contributed by six different kinds cf trees. The comparatively few kinds of trees in our forests that are utilized in large quantities are still more strikingly shown in the case of the pulpwood. Of this material around four million cords are cut each year, valued in the rough at $45,000,000, and from which pulp and paper products are produced to the value of over $200,000,000. More than 90 per cent of these values is furnished by the wood of four kinds of trees.

These few trees enter so largely into the products of the forest not because they are plentiful and accessible, but because they meet the market requirements better than any others. Because of certain inherent mechanical and physical properties, no Canadian wood, for example, is so well adapted to such a variety of uses as that of the white pine. The commercial supply of this species is fast disappearing. Owing to this fact, we are already using poorer woods as substitutes—with little or no difference in price. And again, no wood fibre is so well adapted for paper making as that of spruce. Notwithstanding all that has been said and done with regard to employing various vegetable fibres as substitutes for woodpulp, little has been accomplished or probably ever will be accomplished because of the quality, adaptibility and cheapness of production of wood fibre and among wood fibres those of spruce stand supreme as the result of certain inherent characteristics. When the supply of spruce is gone we shall be compelled to use poorer—but not cheaper—grades of paper.

Now we will turn to our forested areas from the standpoint of the commercially valuable trees. In the first place, of the 3.5 million square miles of land area in Canada, 1.6 million square miles, over 40 per cent, are too cold or too high or too dry to produce trees of sufficient size to interest lumbermen. Around 100,000 square miles should be deducted for agricultural lands outside the grasslands of the West, they having been included in the above. Even with these deductions, we have enormous areas covered by forests, some 1,900,000 square miles (over a billion acres), and again, having their utilization value in mind, let us ask: What kind of forests; what kind of trees? On at least 500,000 square miles climatic conditions are such as to produce only trees

of pulpwood size, practically no trees of sawlog size, that is 12 inches and above in diameter, except in the immediate river valleys.

Destruction of our forests by fire has been incomprehensibly great. The amount of saw timber thus destroyed has been much greater than the amount removed by logging or farming operations since the settlement of the country began, in fact probably greater than all that has been cut in the past plus all that could be cut today. There is little doubt that from one half to two thirds of the forested area of Canada, or in other words around one million square miles (640,000,000 acres) have been burned within the past 75 years and because of such fires do not today contain forests of sawlog size. This reduces the areas containing trees of sawlog size to about one quarter of the total forested area, that is around 500,000 square miles, or approximately 12 per cent of the land area of the country. If we had the population of the European countries or of the United States, this percentage would be far on the wrong side of the factor of safety. In fact, our supply of sawlogs would last the United States at their present rate of cutting not over fifteen years.

Just a little more about forest fires and their effect: Much of this million square miles has been burned not once only, but two, three or even a half dozen times. These repeated fires on the same area make abortive nature's attempt to reclothe the old burns with commercially valuable trees. Whole townships that once supported magnificent forests of pine or spruce are now, because of repeated burnings, covered with worthless brush or with trees of no market value. It is reported that you, in Quebec, have about two thirds of a million acres burned so severely that they are not producing the kinds of trees now being used for lumber or pulpwood. Such areas in Ontario are still larger according to reports. Bear in mind that these are merely estimates. They are not based on actual surveys, although surveys of the burned-over areas are being carried on in both provinces. I fear, however, we shall be simply appalled when the results of such surveys are made public. It is a matter of public record in Ontario, being disclosed by recent investigations of which you may have heard, that certain pulp and paper mills are finding it difficult to replenish from crown lands their waning supplies of spruce. And the reason is—repeated forest fires. This forest devastation by fire is not a thing of the past; it still continues practically unabated, except in wet seasons, in some of the most valuable forest regions of the country, Over a million and a half acres of forest fell prey to the flames in Eastern Canada last summer, but it was an exceptionally dry season.

Even on the areas which have been lumbered and have escaped burning, inferior trees usually take possession after the removal of the valuable pine and spruce, especially where they were mixed with hardwoods. I could show you areas both in Quebec and Ontario where old white pine stumps occur abundantly beneath the present stand of hardwoods or of mixed forest with practically no young pine trees to be found. The pine could not maintain itself after the logging operations. The conditions are considerably better where spruce

has been removed, but not nearly as good as they should be in order to produce a succession of future crops. You will see at once that in order to harvest a crop of trees on the same area, let us say at intervals of ten years, a sufficient number of trees must be ready at each interval to pay the lumberman for cutting them. When he cuts the 12 inch trees, for example, enough 11 inch trees should be left to furnish the next crop, enough 10 inches trees to yield a profitable crop at the third cutting, and so on down through the diameter classes, but with an increasingly larger number of trees in each diameter class downwards because the highest death rate is among the smaller trees. This is what foresters call the proper gradation of diameter classes and it is the basis of successive yields on the same area. Now, investigations have demonstrated that such proper gradation of diameter classes, especially in the smaller diameter classes, is lacking in the cut-over pulpwood forests of the mixed type (hardwoods and softwoods mixed) in Ontario, Quebec and New Brunswick, as revealed by intensive study of small representative areas. The trees that remain after the first, second and even third cutting belong to the virgin forest. They might be called the virgin surplus. When the lumberman cuts over an area ten years after his first cut, he thinks he is cutting the growth that has accumulated in the meantime, but he is not; he is simply cutting the virgin surplus, a part of the virgin forest that he did not take the first time because it wasn't profitable for him to take it. In fact, since the lumbering operations began in this mixed hardwood-softwood forest, say 50 or 60 years ago, there has not been enough regeneration of spruce eventually to replace what has been removed. In other words, the spruce as a tree of future commercial importance is being gradually crowded out of this mixed hardwood-softwood forest.

Under normal conditions forest trees die of disease. Very few die of old age. There is scarcely a healthy tree in a mature forest. Unfortunately, lumbering methods have been such as to increase rather than to decrease the susceptibility of trees to disease. Periodically there comes a combination of man-made and nature-made conditions that produces an epidemic in the forest. Just now the Eastern forests are being swept by a real scourge, the spruce budworm, which has already destroyed, according to the estimate of Dr. J. M. Swaine, 30 years' supply of pulpwood at the present rate of production. The destruction of wood material through such epidemics, however, cannot be adequately measured by the trees killed at the time because the after effects continue for years. The weakened trees becomes susceptible to fungus diseases to which they were previously resistant. The fungus bodies are like cancers. They dissolve away the tissues of roots or stem at the base of the tree until it is overturned by the wind.

Our forests, particularly the older stands, are rotten with fungus diseases. The number of trees that die before their allotted time is enormous and this has an important economic significance. This is an enormous waste of sawlog and pulpwood supplies that will be largely eliminated when conditions are such that our forests can be really managed. Balsam is one of the most susceptible

of the softwoods to fungus diseases. Dr. Faull, I believe, has found over 20 different kinds chewing at the vitals of balsam. This is the reason that we cannot depend upon this species as a source of pulpwood supply in the future.

We do not know as much as we should know with regard to the rate of growth of our forests. If the annual increase is as great as the annual loss, then the forests are self-sustaining and we have nothing to worry about. The chief object of all a forester's efforts is to get the area, over which he has charge, into that condition. Only by procuring a sustained and regulated yield can he furnish a continuous supply of raw material to the wood-manufacturing industries. That is what your Provincial Forester is trying to do. That is what the foresters of pulpwood companies, of which you have such splendid examples in this Province, are trying to accomplish. That is what the foresters all over Canada are striving for—the furnishing of an endless succession of wood crops for the lumbering and the pulp and paper industries.

Let me tell you some ot the things we do know about the rate of growth in our forests. There are many misconceptions as to how fast trees grow in the nature habitat. Some one notices a fast growing forest tree in his field or garden , or in an open pasture and he concludes that trees in the forest grow at the same rate. In the one case, the tree is more or less cultivated and is not subjected to competition by neighbors; in the other case it is subjected to a severe struggle for life from the day it is born, and this expresses itself in retarded growth. I have made growth studies on several thousand trees in the mixed hardwood-softwood type in Ontario, Quebec and New-Brunswick, and I find that in the shade of the over-topping hardwoods, it requires about 30 years to make a spruce tree 1 inch in diameter; the average 4 inch tree is 60 years old; the average 8 inch tree is 120 years old, and the average 12 inch spruce tree is 150 years old. This is in nature's forest undirected by man. Human intelligence, by the proper manipulation of conditions in the forest, could reduce the time required to make a merchantable tree. That is the function of a forester. By planting the trees in old fields he could shorten the period to a much greater extent.

Now, with regard to the growth of the forest itself. Such studies as have been made are not encouraging. It has been found, for example, on areas in the mixed softwood-hardwood type, that have been cut over several times, spruce wood is accumulating at a much slower rate than it has been cut. In some cases as much spruce has been cut in the past 40 years as it took nature 250 years to produce. In other words, the annual growth in the past 40 years has been only one sixth as great as the harvest. It has been stated that if a single spruce tree 8 inches in diameter died on the average acre each year, the loss in wood volume thus ensuing would offset the average annual growth on certain cut-over pulpwood lands in Quebec. The Provincial Forester of Ontario estimates that the annual growth on the average acre of white pine forest in that Province has been only 15 board feet per year for the past 100 years.

This is the yield in board feet of a log 10 inches in diameter and 10 feet long according to the Doyle rule used for scaling logs in Ontario. He also estimates the annual cut of pine to be about one third greater than the annual growth. In fact the Government of Ontario paid back into the treasury $900,000 from the revenues derived from the forests on the assumption that at least that value of material had been taken from the forest capital stock and did not therefore in reality represent current revenue. The published reports indicate that certain pulpwood companies in Quebec have been doing a similar thing for the past few years, a transaction that can be interpreted as an acknowledgement that they are cutting their forests faster than they are growing. It will be seen, then, that such data as we have on the rate of growth in our forests indicate that the annual toll taken by the logging operations, by fire, disease and wind far exceeds the annual accretion of wood by the natural processes of growth.

Briefly, our forest conditions present this problem: Shall we accept for our lumbering and pulpwood industries the wood of constantly decreasing quality which nature unguided produces when the equilibrium in the forest has been upset by fire, disease or logging operations, or shall we exert intelligen effort to maintain our pine, spruce and other valuable forests and thus supply the forest industries with wood of incomparable quality particularly adaptedt to their needs?

It is both a challenge to human intelligence, a necessity from a business standpoint, and the part of patriotism to keep the natural forest areas continuously productive in terms of commercially valuable trees—trees whose products annually increase the wealth of the country by nearly a half billion dollars.

GNATS—BLACK FLIES—SIMULIA

By Dr. J. C. Chapais, St. Denis-en-bas, P. Q.

Last year (1921), about the month of June, one of my Canadian friends, living now in the United States, wrote to me the following letter:

PLATTSBURG, N.Y., June 11th, 1921.

Dr J.-C. CHAPAIS,
Saint-Denis, P.Q.

Dear Sir,—

The various translations I have made while I was living at the I. A. O. have made me familiar with the names of many noxious and useful insects. How-

ever, I have not been able to find out what is the scientific and English name of the insect called in vernacular French *brûlot.* I would be very much obliged to you if you would be kind enough to give me the scientific and English name of that noxious insect, which I only know by reputation. At L. T. nobody could give me any information concerning this insect.

Your humble servant,

F. B.

On the receipt of the above letter, I made an immediate reply as satisfactory as possible to my correspondent; at the same time I resolved to use the reply for the next annual convention of the Quebec Society for the Protection of Plants as the basis of a paper that might possibly be of some use to those who have suffered from the attacks of the Black Fly, but who did not, however, know its scientific name.

I have written at the beginning of this paper three words; the two first as vernacular terms, and the third, as the scientific designation of the "Brûlôt". To give my correspondent the true signification of the term "Moustique" as he wished me to do, I would use the English word "Gnat", to give that of the term "Brûlot" the English words "Black Flies" and to give that of the term "Simulie", the latin word "Simulia". If one adds as the scientific French appellation of that insect the word, "simulie", we will have the complete nomenclature of all the names used to express the term "Brûlot", this plaguy insect which, during certain seasons, torments so sorely our poor humanity.

Now, to indicate the sources which have helped me to give the nomenclature, I shall give, in order of date, the books where I have found the names.

At page 141 of volume 3rd of the "Naturaliste Canadien", (Provancher), in 1871, I find the following reference to the "Brûlot":

" Dipterous insect, vernacularly named: "Brûlot"; French name "Simule"; " latin name, "Simulia". To that reference in the "Naturaliste" I may add: " vernacular English names: "Biting gnat", "Black Fly".

In the sixth volume of "Le Dictionnaire des Dictionnaires", by l'abbé Paul Guérin, published in 1886, I find, under the head of "Simuli", the following lines: "Genus of dipterous nemocerous insects, family of Bibionidae; Slender " flies, vernacularly called Biting Gnats". Short antennae with eleven " articulations, palpi with four joints, the last being long; no ocelli. The " females only are blood-suckers. Simulia Columbaschesis are found in " Hungary, where it attacks in clouds the herds of oxen (Claus); *simulia* " *pertinax, ornatis,* Southern America. Fossil *simulia* are found in the Weal- " den formation (*Simulia humida*)."

At Page 5641, 2nd column of volume VIIth of "The Century Dictionary and Encyclopedia" published in 1889, we find the following lines relating to the *brûlot*:

" *Simulium.*—An important genus of biting gnats of the family *Simuliidae.* " They are small, hump-backed gnats, of a grey or blackish color, with broad

" pale wings. Many well known species belong to this genus, such as the colum-" batsch midge of Eastern Europe, the black fly (*S. Molestum*) of the wooded " regions of the Northern United States and Canada, and the Buffalo and Tur-" key gnats of the South Western United States. Their bite is very painful " and they sometimes swarm in such numbers as to become a pest. Their " larvae and pupae are aquatic, and generally live in shallow swift running " streams. Also *Simulia*."

One will note that in 1886 as written above, *Le Dictionnaire des Dictionnaires* of Guérin classifies the Simulium in the Family of the Bibicnidae and that in 1889 the Century Dictionary and Encyclopedia classifies it in the Family of the *Simuliidae*.

In the volume "Entomologie et parasitologie agricoles", page 418, a book written in 1917 by Georges Guénaux, Paris, France, under the head "Simulia" will be found the following: "Simulia are very minute biting gnats which flutter " about in large numbers and of which the females sting men and animals, " suck their blood and may inoculate them with contagious diseases. Those " twowinged nemocerous insects are distinguished from mosquitoes, in having " short and wide wings, wide and flattened legs, thick and short proboscis."

" The ash-colored simulium (*Simulium maculatum*) is three millimeters. " in length and has its body ash-grey and the abdomen striated with black. " It flies in spring and, by its stings, maddens the pasturing herds; very often " it penetrates into the horses' ears and drives them wild. As a resul of many " observations, it is now thought that it sometimes inoculates anthrax."

THE SPRUCE BUDWORM IN QUEBEC PROVINCE

(Extracted from a paper given at the Annual Meeting)

By J. M. Swaine, Chief, Division of Forest Insects, Entomological Branch, Department of Agriculture, Ottawa

About twelve years ago a great outbreak of the spruce or, better, the balsam budworm developed in the vast balsam-spruce forests immediately south of the Height of Land in the Province of Quebec, between Grand Lake Victoria and the country north of Lake St. John. During the next few years this infestation developed southward across the St. Lawrence and eastward over northern Maine and New Brunswick, but missing the end of the Gaspé Peninsula.

The primary budworm outbreak lasted only about three years in each affected district in Quebec Province and then died away leaving in its wake an enormous quantity of dead, dying and weakened balsam and less seriously

injured spruce. In New Brunswick the budworm outbreak apparently lasted longer in some localities and the primary injury was accordingly perhaps more severe. Serious injury to spruce has been confined almost entirely to red spruce which occurs in Southern Quebec and in New Brunswick.

The weakened balsam left by the budworm outbreak was attacked by the Balsam Bark Weevil, *Pissodes dubius* Rand, the Balsam Bark-beetle, *Pityokteines sparsus* Lec., and the Sap Rot Fungus, a species of *Armillaria.* These three destructive agents have been and still are killing great quantities of the remaining unthrifty balsam each year in much of Quebec Province, south of the Height of Land and in New Brunswick, so that, on great areas, in the aggregate thousands of square miles in extent, almost the entire stand of balsam has already been killed or evidently will die within the next few years.

The development of the budworm outbreak towards the west was much less rapid. Although it passed in a few years southwesterly over the DuMoine and Kipewa watershed and finally died away in the hardwood and cultivated areas of the Ottawa Valley the progress directly westward along the Upper Ottawa River north of Lake Expanse and towards Lake Abitibi was apparently exceedingly slow. Our first reports of possible budworm injury in that little known country were received in the fall of 1919. During the summer of 1920 our surveys revealed an enormous budworm outbreak about Long Lake in Western Quebec and extending across the Ontario boundary almost as far as Lake Temagami. Forest sample plots were laid out near Long Lake to aid in detailed studies, and surveys by canoe were undertaken to determine the area of the infestation, the western margin of the outbreak and the direction in which it was spreading most rapidly. The injury we know would affect only the balsam and spruce and would be most severe in stands containing a high percentage of balsam. These stands were located very often in the centre of the blocks into which that part of the country about Lake Temagami is divided by the water courses and the belts of pine with which they are bordered.

It was evident that the only way to obtain rapidly the information we desired was to view the infested country from the air and map the diseased areas as determined from the changed colour of the dead and affected trees. For a few weeks during the last two summers we have carried out a hydroplane survey of the region and have been able to determine the extent of the area affected and, roughly, the western boundary of the outbreak.

Until last summer, in Quebec Province, we were studying the after-affects of a budworm outbreak since the caterpillars had largely disappeared from the Quebec forest, excepting possibly the country north-east of Lake Expanse, before we commenced our investigations. In New Brunswick the primary budworm outbreak continued until last summer and although it has now nearly disappeared in that Province as well, it has left behind it a terrible wreck

of dead and dying balsam and a considerable amount of dead and seriously injured red spruce.

It should be emphasized that although the primary budworm outbreak has been over for some years in probably all of Quebec Province, except the western portion already mentioned, the weakened balsams have continued to die until the present on very large areas, through the action of the beetles and fungi which accompanied and followed the budworm attack, and it is evident now that in the older and more heavily injured stands, growing under less favourable conditions, this injury may be expected to continue until the greater part cf the balsam is killed.

In Quebec Province west of the St. Maurice Valley and south of the Height of Land, the balsam of pulpwood size is in large part dead or dying. Throughout a broad belt from Lake Kipewa through Lake DuMoine, Grand Lake Victoria and the Baskatong apparently over 90% of the balsam is dead and fallen. In the area between the St. Maurice Valley and the Saguenay and Lake St. John, the injury has varied in intensity; apparently between 25% and 90% of the balsam is dead, with the average probably 50% of the balsam stand or more. Our reports from the Upper St. Maurice Valley indicated a loss of less than 25%, and we have made no surveys there on that account. We need further information about the loss in that region.

South of the St. Lawrence the loss has been less severe, probably an average of about 25% of the balsam; in places the red spruce has also been severely injured, and in some sections a considerable quantity of spruce has been killed. The Gaspe Peninsula proper has escaped entirely this budworm outbreak. So far as we know the only *active budworm outbreak* in Quebec Province at present is that already mentioned as extending across the inter-provincial boundary into Ontario from the country north of Lakes Quinze and Temiskaming. In this country nearly 50% of the balsam is dead now and the rest probably will be dead within the next 5 years.

It is not possible to estimate the quantity of timber killed with any great degree of exactness from the data now available to us. We have no means of knowing how much balsam originally existed on the great area immediately south of the Height of Land upon which the most wholesale injury occurred; but, judging from information we have, and exact estimates which have been made on considerable areas, it would appear that the quantity of balsam which has already died in Quebec or which almost certainly will die within the next few years cannot be much less than one hundred million cords and is probably much greater than this.

Danger from Fires

It is evident that the fire hazard caused by this great quantity of dead and dying trees constitutes a most serious danger. There can be no doubt that fire fighting will be made more difficult for the next few years from this cause, and there was evidence last year that certain large fires spread largely in this dead and dying balsam.

Insects concerned in the Injury

The Spruce or Balsam Budworm, *Harmologa fumiferana Clem.*, is a small brownish caterpillar about three-fourths of an inch in length when full grown. The adult insect is a small, yellowish-brown moth which flies readily, deposits its eggs on the needles of living trees and so distributes the injury. The tiny caterpillars, which have overwintered on the twigs, appear in the early season and attack the opening buds and young foliage. They feed upon balsam, spruces and hemlock; but they affect the greatest injury to balsam and red spruce. When the caterpillars are exceedingly numerous, as in an outbreak, the young foliage on the balsam is largely or completely destroyed and the older needles eaten to a varying degree. Before the dead needles have fallen, the badly infested trees have a reddish, scorched appearance, which is replaced by a greyish color in the later stages of the infestation after the foliage has largely disappeared. The caterpillars are abundant usually for only two or three years, dying out through the combined effects of parasites, predators, lack of food supply and adverse weather conditions. Towards the close of the outbreak redtop balsams, i. e., dead trees with all the remaining foliage turned red, appear, indicating the work of the beetles and fungi which seem invariably to follow a budworm outbreak.

The Balsam Bark-beetle, *Pityokteines sparsus* Lec., is a very small, black beetle, one-eight of an inch in length, found, with its small whitish grubs, cutting tunnels in the inner bark on the surface of the sapwood of weakened and dying balsams. The beetles excavate a minute entrance tunnel through the bark, terminating in a small flattened chamber on the surface of the sapwood, from which radiate several egg-tunnels. These, together with the entrance tunnels, are kept free from boring-dust. The star-shaped tunnels thus formed are occupied by one male and several females, one for each individual egg-tunnel. The eggs are laid in niches along the sides of the latter, and the tiny white larvæ or grubs excavate slender larval mines which are packed behind the larvæ with dustlike excrement. The larvæ pupate in the ends of their mines and eventually cut their way through the bark to freedom to attack fresh balsam slash, and weakened or recently killed trees.

This species breeds abundantly in balsam slash and in dying and weakened balsams but rarely, if ever, attacks healthy trees.

The Balsam Bark Weevil, *Pissodes dubius* Rand., is a greyish snout beetle, with whitish markings, about one-quarter of an inch in length. The beetles appear in the spring and deposit eggs in groups of punctures in the bark of the trunk of standing balsams. The resin which exudes from the punctures hardens and forms whitish patches on the bark which are more or less characteristic of the injury. The larvæ which hatch from the eggs excavate very long mines in the inner bark, from six to twelve inches in length, radiating from the group of egg punctures, and left filled behind the larvæ with reddish excrement. The larvæ are about one-quarter of an inch in length when mature. They pupate in the ends of the tunnels and eventually emerge through individual exit tunnels cut through the overlying bark, leaving a round exit-hole.

This species does not oviposit in dry trees or old slash. It attacks weakened balsams and may affect trees showing little evidence of being unthrifty. The work of this species is easily distinguished from that of the Balsam Bark-beetle through the absence of egg-tunnels, the larger grubs, and the longer, larger mines, radiating from the egg-punctures.

Control

When we commenced our study of this problem the primary budworm outbreak was over, in the greater part of Quebec Province, and the secondary bark-boring beetles were attacking the weakened and dying trees. There was, therefore, no possibility of controlling the budworm; its work was already done. It should be clearly understood that the problem we have now to deal with in Quebec, except for the extreme western section, is not at present the control of a budworm outbreak, but rather the control of the beetles which followed the budworm, the salvage of the standing and dying and weakened balsam and the development of a system of forest management, supplemented by possible direct control, which will prevent another calamity from the same cause in the years to come.

Our aim has been to obtain all information available regarding the injury, the factors which affected its rise and fall and to determine some methods of avoiding the greatest loss from the next budworm attack. We may not have another outbreak for a generation, or more, but when it does come these conditions will probably obtain; the percentage of balsam in Quebec forests will be very much higher than it was 10 years ago and our pulp industry will be dependent very largely upon balsam for its wood supply. This high percentage of balsam will invite a very heavy injury; but if we can manage to have a healthy stand of growing balsam without large areas of mature and overmature timber or if the percentage of spruce in the coming stands can be increased, the effects of an outbreak will probably be much less destructive.

Utilization of dead and mature balsam

It is evident that the dead, dying and mature balsam should be utilized wherever and as rapidly as this is commercially feasible. As a matter of economy, as much as possible of the standing dead material should be utilized. The balsam and spruce are usually perforated by the large tunnels of wood borers within two years subsequent to their death, and the action of fungi destroys the quality of the wood very rapidly, more quickly in the balsam than in the spruce.

Control of beetles

As already stated, although the budworm itself has disappeared from the greater part of the province, the balsams are still dying rapidly in many places through attack by the secondary barkboring beetles and the sap-rot fungus. These attack the bark of the trunk and kill the trees in one year, causing them to turn red. The control of these beetles should be feasible under some circumstances. When these red-top trees are becoming abundant and a valuable stand of balsam is apparently threatened, it will evidently be profitable to cut out the infested trees during winter and put them in water in early spring and thereby prevent the spread of the injury. This is being carried out on a considerable scale by one Quebec company this winter.

One of the beetles concerned, the Balsam Bark-beetle, breeds in slash and burning the slash will destroy, in addition, other boring insects and heart rot fungi which are injurious in the forests. This is an additional reason for urging that slash burning must form a part of any permanent forest policy.

Cutting out the red tops will be profitable only in special cases. Slash-burning is only a help in this matter of control. In badly injured areas where balsams are still dying rapidly, the policy should be to concentrate on the balsam cutting in so far as is feasible, so as to salvage as much of it as possible and also thereby leave the future stand in a young and thrifty condition.

Direct Control Methods

Direct control for an active outbreak of this nature spreading over hundreds or thousands of square miles is almost inconceivable. This could be accomplished only by destroying most of the caterpillars in the badly infested sections through fire, through extensive cuttings of infested trees, or by means of poisons. Of these, the distribution of poison dust by an air machine flying low over the trees is the only plan that seems theoretically feasible, and it is hardly so at the present time. A somewhat similar experiment was carried out in the Eastern United States this summer in which a block of 5,000 catalpa trees affected by caterpillars was treated with poison dust distributed from an aeroplane, and it is reported, with complete success. Before the next bud-

worm outbreak arrives, we hope to have an intelligence system in operation through which the insect activities in all parts of the forest will be reported to the entomologists; and, when it is found that a fresh budworm outbreak is threatening, it may possibly be feasible, using the planes and poisons that will be in use by that time, to destroy the carterpillars in sufficient numbers to check an outbreak effectively. At all events, it will certainly be tried by our successors. The present primary outbreak in the Temiskaming is too widespread to be dealt with successfully by our present appliances; but we shall at least test the effectiveness of the method if a suitable opportunity offers.

It is becoming more evident to us, as we study these problems, that our chief hope for a healthy, thrifty forest in Eastern Canada in the future must depend upon the development of policies and plans for forest management.

Summary of Suggestions for Control

Utilization of balsam as soon as it reaches maturity under its local condition, in the hope that a healthy growing stand will not encourage a budworm outbreak.

Utilization of dying and dead balsam for salvage and the removal of fire hazard. It is important to salvage as much of the dead and dying timber as possible before it becomes an entire loss, a matter of two years usually for both balsam and spruce through the action of wood borers and fungi, and it is also of the greatest importance to reduce as much as possible of the combustible material.

Cutting out red top balsams during winter combined with slash burning to control balsam weevil and balsam bark-beetles.

Future slash burning to prevent development of the Balsam Bark Beetle.

Application of poisons by hydroplane in initial stages of future budworm outbreaks. Some such method of direct control may be feasible in the future although the difficulties seem at present almost insurmountable.

Forest management to encourage types of forest least susceptible to budworm injury, the utilization of spruce and balsam before overmaturity, better adaptation of type to soil, and the utilization of hardwoods so that a budworm immune mixed hardwood-coniferous forest may be commercially profitable. This important feature of the problem is discussed in detail in Craighead's paper on "Possibilities of Preventing Losses from the Spruce Budworm in the Proceedings of the Quebec Forest Protective Conference for 1922".

A Forest Insect Intelligence System

It is hoped to establish throughout our eastern forests, an intelligence system, through co-operation between foresters, lumbermen, all travellers of the forests, and the forest entomologists whereby the entomologists will

receive regularly from all parts of our forest area reliable reports upon all important insect injuries. With this system in operation it will be possible to discover insect outbreaks in their initial stages, to make an expert examination and to put in effect whatever direct control measures may at that time have been devised.

The perfection of this intelligence system will prove without question a most effective aid in avoiding and controlling serious forest insect injuries.

CHEMICAL WOOD PULP IS ATTACKED BY MOLDS

By R. J. Blair, Pathologist, Forest Products Laboratories of Canada

Wood pulp manufacture falls into two main divisions known as the mechanical and chemical processes. Mechanical pulp often spoken of as groundwood is made in a machine where sticks of wood are held against a revolving grindstone. For chemical pulp the wood is first cut into chips which are cooked in large digestors at high temperatures under pressure. For cooking the chips the digester is filled with a chemical solution which dissolves the lignin from the wood leaving the fibre behind in a more or less impure form of cellulose. According to the chemical used for the cooking liquor, three different kinds of pulp are made known as sulphite, sulphate and soda. Each of these kinds of pulp may be subsequently bleached.

An idea of the importance of the industry to Canada may be obtained from the following figures. In 1920, 2,777,422 cords of pulpwood were manufactured into pulp by the various processes. The wood used and pulp produced are as follows:

Kind of Pulp	*Cords of Wood*	*Tons of Pulp*
Groundwood....................	1,080,618	1,090,114
Sulphite........................	1,354,023	675,733
Sulphate.......................	330,907	188,487
Soda...........................	11,874	5,768

Part of this output is made into paper immediately but a considerable portion is either exported or stored in Canada before it can be used up. For various reasons several months often elapse from the time the pulp is manufactured until it is made into paper and it is during this interval that losses due to molding occur.

Work upon the molds affecting groundwood pulp has been carried on by the Bureau of Plant Industry of the United States Department of Agriculture,

but so far as is known no reference has been made anywhere to attack of chemical wood-pulps by molds. The purpose of this short article is to state that material has been submitted to the Forest Products Laboratories of Canada showing a molded condition in sulphate and soda pulps and sulphite both bleached and unbleached.

The first appearance of moldiness occurs as small discoloured spots of which a number are often found in a single sheet. The discoloration is usually dark grey, black or brown but it may also be greenish, yellowish or a deep pink. At the outset the actual harm done to the pulp may be very slight, consisting

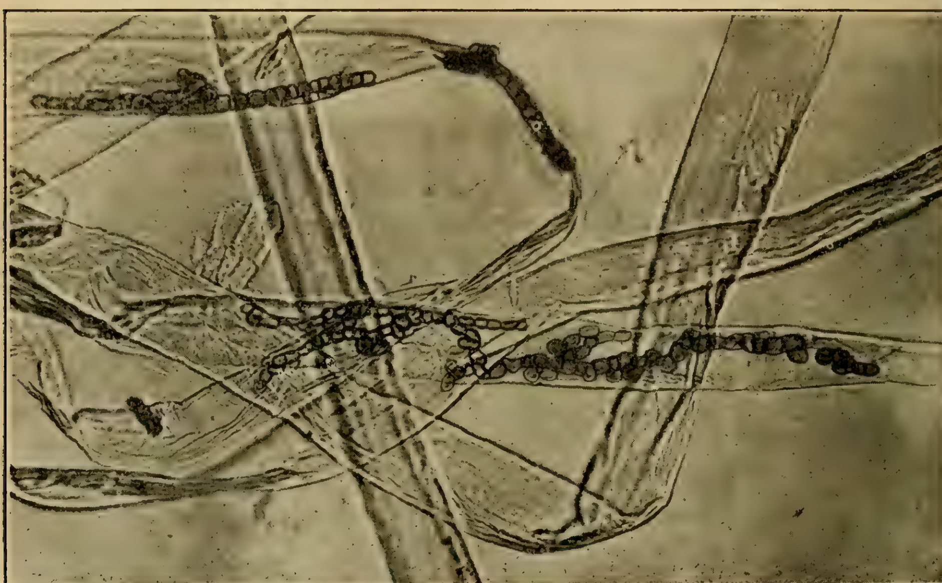

FIG. 1.—Fibres taken from mold spot in Sulphite pulp. x 300

principally in a discoloration limited to small areas. If the action is not checked the discoloration spreads until the pulp finally becomes worthless. The early discoloration may lower the price of the pulp out of all proportion to the actual damage caused as the small amount of material containing the coloured matter is so broken up in the beater that the colour of the paper made from it is not appreciably changed.

The accompanying photomicrographs show conditions found in the different kinds of pulp studied.

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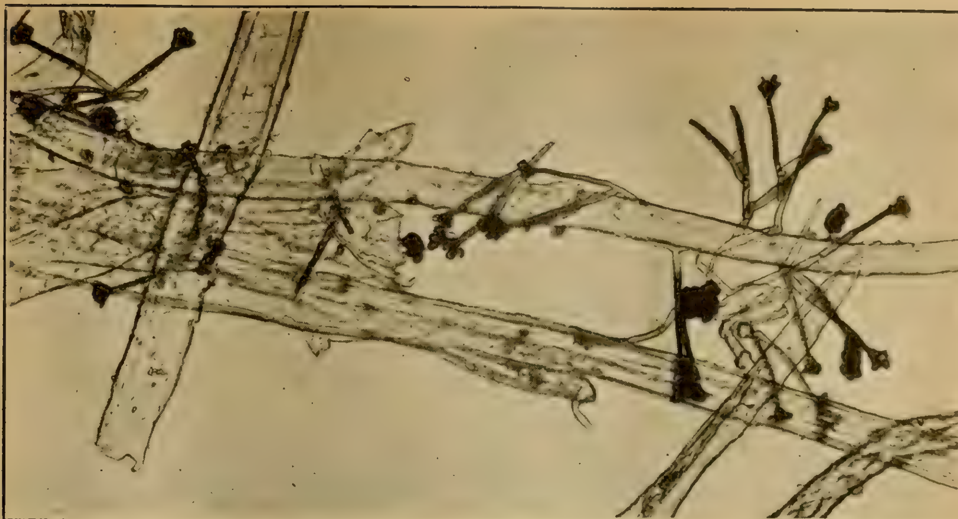


FIG. 2.—Fibres taken from mold spot in Sulphate pulp. x 300.

FIG. 3.—Fibres taken from mold spot in Soda pulp. x 300.

A FEW POINTS OF INTEREST IN CONNECTION WITH FOREST ENTOMOLOGY

By M. B. Dunn, Assistant Entomologist, Entomological Branch, Ottawa

A great many attempts have been made to estimate the actual damage done to the forests of Eastern Canada during the last few years by the spruce bud worm. All of these, it matters not how carefully they may have been carried out, must necessarily be but rough approximations, but they at least serve to convey some idea of the terrific havoc for which this insect is responsible.

Last year in New Brunswick, we ran a number of test strips, 30 x 100 feet. These strips were located in varying types and sections of the country, having only this in common that they all had at least a little of the largest timber taken out. All standing trees whose appearance denoted that their death was directly attributable to the bud worm were counted and the diameter of each at four and one-half feet from the ground was taken. With volume tables kindly supplied by Mr. Wm. Robertson, of the Dominion Forestry Branch, the loss in merchantable cubic feet for each strip was estimated and an average made for the various strips. The average proved to be 118. merchantable cubic feet for balsam and 11.7 for spruce. Carrying these figures a little further, and estimating the number of strips per square mile, we find the loss in the province of New Brunswick, which has a main forest block of approximately 100 miles square, to be in the neighborhood of 10,900,000,000 merchantable cubic feet for balsam and 1,087,000,000 for spruce. These figures seem appalling. They appeared incredible at first, even to the men who did the work, and we went over our calculations several times in the hope that there was a mistake somewhere, but none could be found.

As a further illustration of just how much lumber such a pile would be, it can be estimated that if one had such an amount in manufactured lumber at his command, he could begin to build cosy little seven roomed houses at Halifax and, leaving only twenty feet between each house, he cold build four rows of such houses clear across Canada to Vancouver.

Now this loss was all in the Province of New Brunswick in a comparatively small area. When one remembers how many times larger is the forest area of Quebec and Ontario, and also that some of it at least is virgin territory for which these figures would be too small, one begins to get some vague idea of the damage which has been done. Added to this certain loss there is the almost certain one due to forest fires which, owing to the dry condition of the timber, can now hardly be prevented from raging over a large part of this territory.

Another interesting phase of our work is that in connection with sample plots. In co-operation with the Conservation Commission and several lumber companies, we have established at various points throughout the forests of Eastern Canada, a total of thirty-two sample plots. We have under observation on these plots slightly over twelve thousand trees, mostly spruce, balsam and pine.

The method of establishing these plots is briefly as follows. A suitable location is chosen and a rough line is run around a block of one or two acres. The trees on this block are then consecutively numbered, either with white paint or by means of aluminum tags, fastened to the trees with copper wire or copper or brass nails. The paint method is probably much the better since it is considerably cheaper and it has this advantage, that individual trees are very much easier of subsequent location.

Sample plots are proving of invaluable aid to forest insect problems. Without exact records of individual trees continued over a number of years, it is practically impossible to obtain satisfactory data on certain phases of the work. On the sample plots, however, where the numbering of the trees makes their annual location easy, entomological investigations can be conducted with much greater efficiency than is otherwise possible. The sample plot is not intended as a direct control measure or anything of that sort, of course. Its value lies entirely in the field of experimental investigation, and it offers a sure and efficient method of learning everything possible about the life history and habits of the various insects upon which we have to make war. When we get all these facts within our grasp, then, and only then, will we be able to arrive at methods of control which will effectively check in their incipiency any dangerous forest insect outbreaks of the future.

EXPERIMENTS ON THE CONTROL OF THE ONION MAGGOT, 1921

By W. Lochhead and W. J. Tawse, Macdonald College

In collaboration with the Dominion Entomological Branch, the Entomological and Horticultural Departments of Macdonald College carried out experiments in the spring of 1921 against the onion maggot. For several years this insect had caused severe losses to the onion crop in the truck gardens in and about Montreal, and the owners gladly placed their fields at the disposal of these Departments for testing out any method which gave promise of relief.

The experiments were conducted on six farms, viz., in Rosemount on the farms of J. and M. McEvoy, in Outremont on the farm of Paul Wattiez, in Cote des Neiges on the farms of A. Savoie and A. Deguire, and at Macdonald College.

The Arsenic Bait.—The method of control selected was the application of poisoned bait of sodium arsenite and molasses, prepared as follows:—¼ oz. sodium arsenite was dissolved in one gallon of boiling water, and 1 pint of cheap molasses added. This bait was applied in two ways:—(1) in shallow pans, placed at regular intervals throughout the field, and (2) as a spray.

The pans used were round shallow tins, about 1½ inches deep and 6 inches wide, costing 7½c each.

Into each pan a small lot of excelsior was placed and the sodium arsenite mixture poured upon it, with the idea that the flies would the more readily get access to the mixture. About 20 pans were used per acre, and they were refilled every week for four weeks.

When the sodium arsenite mixture was applied as a spray, an ordinary watering can with a small nose was used. Acre plots were treated quickly when the operator began at one end of the plot and walked diagonally across the crop back and forward in a V-shaped manner, the strips being about 15 or 20 feet apart at the wide end.

The first application was made when the plants were three or four inches high, and four or five further applications made about a week apart. Bright calm days should be chosen for such work.

Life-history of the Onion Maggot Fly.—The adult flies, which are about ¼ inch long and bristly, begin to appear about the middle of May, and about *ten days afterwards the females begin to lay their eggs* on the leaves. These are cylindrical, white and distinctly ridged. The eggs hatch in three to five days, and the maggots are white, cylindrical and less than half an inch long when full grown in 2 to 5 weeks. They work their way down within the sheath of the leaves to the forming bulbs in which they feed.

When the maggots are full grown they form oval, brown puparia, either in the outer layers of the bulb or in the soil, about 2 to 5 inches below the surface. In about two weeks flies emerge from the puparia. There are probably three broods a year, and they pass the winter as *puparia in the soil.*

The control method is based on the fact that the flies do not lay their eggs until about ten days after emergence from the ground, and that they are fond of sweet substances.

Following are the results and summaries of the experiments:—

MONTREAL ONION MAGGOT CONTROL WORK, MONTREAL.

Location	Name	No. of Acres	No. of Pans	% control Treated	% attacked untreated
Rosemount.....	J. McEvoy...	2	40	98%	
		1½	30	92-95%	
		4	Spray.....	80-85%	
	M. McEvoy..	10	200	....	20% before pans were put out.
Outremont.....	Paul Wattiez.	1	20	90-92%	
		1	Check.....	....	15-20%.
Cote des Neiges	A. Savoie....	2	40	98% or 420 bus.	
		2	Check.....	....	6% (393 bus. yield.)
Cote des Neiges	A. Deguire...	2½	50	96%	
		2½	Check.....	....	10% attacked.

ONION MAGGOT CONTROL

On the farm of Mr. Jack McEvoy, Rosemount, Montreal

1st plot next the highway above the storage.
2 acres, requiring 40 pans.
2nd plot below far storage in the centre of the farm.
1½ acre requiring 30 pans.
3rd plot just beolw the first storage house was sprayed with the watering can diagonal bait.
Pans set out and filled May 27—28th.

2nd.	Refilled May	31—Weather hot and dry.	
3rd.	" June	6—Owner refilled on the 2nd and again on the 4th on account of heat and heavy rain on June 3rd.	
4th.	" "	10—.	
5th.	" "	15.	

Note:—The spraying was carried out each time the pans were filled.

Summary of Observations

I.—First, the two acre plot above the storage was 98% free of maggot injury. Numerous counts showed from 12 to 20 dead flies in and around the pans.

II.—Secondly, the one and a half acre plot below the far storage showed very little injury with the exception of the end near the manure pile next to the storage. This end was attacked before we set out the pans as the heating manure provided seemingly an ideal refuge against the cold winds and nights. Observations during the fly period and latter throughout the summer did not change the proportion affected by the maggot, which was placed at 5–8%.

III.—The third plot of four acres on which was tried the diagonal watering can spray was situated just back of the first storage house. The results here were not to be compared with the pan control as the spray seemed to dry too quickly and as a result there were 20% or more of the onions attacked by the maggot. This field was also attacked by onion smut (*Urocystis Cepulae*) which further reduced the yield.

IV.—The fourth plot of Mr. M. McEvoy's consisting of ten acres was left for a check as he had not previously been bothered with this pest. However, on June 10th, the field was so badly attacked that Mr. McEvoy secured 200 pans and treated the whole piece, which quickly controlled the flies, as we counted in and around the pans twelve to twenty eight. Beyond patches here and there this field finally turned off a fair crop of onions for the past season of good average size.

These growers were very pleased with the results obtained from the pans as they were easily and quickly refilled and did not hinder cultivation. They did not, however, like the diagonal spray as it required twice the amount of liquid and was not nearly so easy to apply. It required more material and time to apply while the damage to the standing crop was only kept down by carefully watching the rows.

The four-acre plot at Mr. J. McEvoy's, where the diagonal spray was used.

A two acre plot in front of storage plant at Mr. J. M Evoy's—98% stand.

The ten-acre plot of Mr. M. McEvoy showing Maggot damage very heavy in spots.

ONION MAGGOT CONTROL WORK

On the farm of Mr. A. Savoie, Cote-des-Neiges, Rd.

Plot of two acres of the four acre field. Required forty pans.
Set the pans out on May 26th, 1921.
Refilled the pans —June 1st.
" " " June 7th.
" " " June 14th.
" " " June 18th.

Mr. Savoie weighed the onions :
1 acre treated giving 420 bus.
1 acre untreated gave 393 bus.
Estimated control 98%. Attacked 6%.

ONION MAGGOT CONTROL WORK

On the farm of Mr. A. Deguire, Cote-des-Neiges, Rd.

Plot selected consisted of two and a half acres (2½) requiring fifty pans.

These pans were set out and refilled on the same dates as Mr. Savoie's. We were unable to get the final yields as in the owner's absence the hired help lost the count and before this was discovered the onions were all in several storages. The observations noted throughout the season brought out the fact that this pest is not nearly so numerous as in the Rosemount area. The untreated plot was thinner in patches, but when pulled averaged larger in size. The treated was estimated at 96% control while the loss on the untreated was not more than 10%.

ONION MAGGOT CONTROL

On the farm of Mr. P. Wattiez, Outremont, Montreal.

Plot of 2 acres divided in half. The lower end treated with twenty pans and the upper end left as a check.
The pans were set out on May 26th.
Refilled June 2nd, 6th, 14th.

On June 18th these plots were examined and found in the case of the treated plot to be only lightly affected estimated at 8-10%. The untreated plot was much worse, showing many blanks and wilted spots estimated as 15-20%.

The whole crop was sold as bunch onions as soon as the bulbs were large enough for kitchen purposes.

ONION MAGGOT CONTROL

In the Horticultural Gardens of Macdonald College

I.—Plot consisting of one-third of an acre.
Near old onion ground requiring 7 pans. block 1.
II.—Plot of one third of an acre in block II as a check two hundred feet away.
III.—Plot of one third of an acre in block IV seven hundred feet from the check for the diagonal spray.

Pans set out May 26th. Refilled 31st, June 6th, 14th. The first block under the pan system was badly attacked as it was close to the old onion ground of previous years. We estimated the damage at 15—20% on the one end. The plot yielded 78 bushels.

The second plot used as a check consisting of one-third of an acre was attacked very lightly in spots. The damage was estimated at 5%. The total yield could not be secured as 1-6 of the block was sold as bunch onions in August. The other sixth yielded 45 bushels.

The third plot for spraying was practically free of maggot as nearby were planted two rows of seed onions which attracted the flies. This plot yielded 96 bushels.

COST OF ONION MAGGOT CONTROL

Cost of Pans, 20 per acre, at 7½c	**$ 1.50**
Sodium Arsenite, 2½ oz at 60c lb	**.10**
Molasses, 1¼ gallon at $1.35	**1.69**
Cost of arranging and putting out pans, 2 hrs at 30c	**.60**
Cost of refilling pans 4 times, 4 hrs. at 30c	**1 20**
Total cost of treating per acre	**$ 5.09**

THE DISTRIBUTION OF THE EUROPEAN CORN BORER IN CANADA AND THE UNITED STATES

By W. N. Keenan, Assistant Entomologist, Division of Foreign Pests Suppression, Entomological Branch, Department of Agriculture, Ottawa.

Outbreaks of foreign insects usually do not occur until several years after the species have been introduced into new environments. This rule seems to have held in the case of the European Corn Borer, as the insect was not discovered in the United States until 1917 (in the Boston vicinity), and its establishment in Canada was not recognized until 1920, whereas there is almost conclusive evidence that it was first introduced in shipments of broom corn into both countries about the years 1909 or 1910.

Area infested in the United States

An investiga ion of he original discovery in M ssachusetts, which was carried on in 1917 and 1918, showed that the pest was present in thirty two townships in the counties of Essex, Middlesex, Suffolk and Norfolk in Massachusetts. Early in 1919 a new area was discovered in eastern New York State in the vicinity of Albany and also late in the same year in western New York State. Collections were also taken in New Hampshire and Pennsylvania during the same season and at the end of 1919 he infested area comprised 111 townships in Massachusetts in the counties of Barnstable, Essex, Middlesex, Norfolk, Plymouth and Suffolk; 3 townships in Rockingham County in New Hampshire; 26 townships in the counties of Albany, Fulton, Montgomery, Rensselaer, Saratoga, Schenectady and Schoharie in New York State (*eastern*); 13 townships in Cattaragus, Chautauqua and Erie counties in New York State (*western*) and one township in Erie County, Pennsylvania.

As a result of further scouting carried on in the United States during 1920, 15 additional townships in Massachusetts, in the counties of Plymouth, Norfolk, Middlesex and Bristol were added to the quarantined areas, as well as 5 townships in Rockingham County, New Hampshire; 12 townships in New York State (eastern) in the counties previously mentioned; and 14 townships in Chautauqua, Niagara and Erie Counties in New York State (western).

In 1921 the spread of the insect seems to have been the greatest, as specimens were collected in many new townships, some distance from the old points, and at the present time the area under quarantine for the corn borer in the United states comprises the following:

Massachusetts

One hundred and forty-three townships in Barnstable, Bristol, Essex, Middlesex, Norfolk, Plymouth and Suffolk counties.

New Hampshire

Twelve townships in Rockingham county.

New York (eastern)

Sixty-nine townships in Albany, Fulton, Hamilton, Montgomery, Renselaer, Saratoga, Schenectady, Schoharie, Washington and Warren counties-

New York (western)

Forty-six townships in Cattaraugus, Chautauqua, Erie and Niagara counties.

Pennsylvania

Twelve townships in Erie county.

Ohio

Forty-two townships in Ashtabula, Cuyahoga, Erie, Lake, Lorain, Lucas and Ottawa counties.

Michigan

Three townships in Monroe county.

The 1921 results represent an increase of 127 townships in the infested area, making a total of 327 townships under quarantine at the present time or approximately 9253 square miles.

Area infested in Canada

As previously stated, the European Corn Borer was not discovered in Canada until 1920. In that year two separate infestations were found in Ontario. The first and less severe of the two comprised 3 townships in Welland County and two in Haldimand County, bordering Lake Erie. The second infestation centered about the St. Thomas district and included all of Elgin County, the majority of Middlesex County; 6 townships in Oxford County, 4 townships in Kent County, and one in Huron County; a total of 35 townships and covering an area of 2780 square miles.

In 1921, in Ontario, we also experienced a much greater spread of the insect than was expected. A total of 65 additional townships were found infested and it was considered advisable to add seven others to the quarantine on account of their respective situations. At the present time there are 107 townships under quarantine in southern Ontario, covering a total of 8214 square miles and including the following areas; *Welland*, *Haldimand*, *Brant*. *Norfolk*, *Oxford*, *Waterloo*, *Middlesex*, and *Elgin* counties; the townships of Clinton, Cainsboro, Grantham, Louth, and Niagara in *Lincoln* county; the township of Ancaster in *Wentworth* county; *Perth* county with the exception of Elma and Wallace townships; the townships of Goderich, Stanley, Tuckersmith, Hay and Stephen in *Huron* county; the townships of Warwick, Brooke and Euphemia in *Lambton* county; the townships of Orford, Howard, Harwick, Raleigh, Tilbury East, Romney, Zone, Gore of Gamden and Camden in *Kent* county; the townships of Mersea, Gosfield South and Pelee Island in *Essex* county, and the township of Pickering in *Ontario* county.

As will be noted there was enormous spread of the insect in Ontario in 1921 but as all conditions were unusually favorable it is hoped that a much less area will be involved in the succeeding season's spread. The majority of the increased distribution is apparently natural but the isolated collection in Pickering and the Essex and southern Kent County infestations indicate artificial transportation of the insect.

An examination of the areas infested by the corn borer in the United States and Canada and the conditions accompanying each area suggests at least four centres of infestation: Massachusetts, New York (eastern), New York (western) and the St Thomas district in Ontario. The 1921 results would indicate that lake shore conditions are very favorable for the spread of the insect, as collections were made in practically all townships surrounding Lake Erie. This may be due to any one of several factors including water currents into which infested corn refuse has found its way, wind currents with adults in flight, and shipping transportation

The importance of the European Corn Borer as a pest is recognized by all who have seen the results of its work Every effort, both in the United States

Map showing areas infested in black.

and in Canada, is being made to reduce its spread to the minimum and to devise the best methods for treating infested areas. Quarantines have been placed on the infested townships in both countries which prevent the removal to outside areas of products liable to harbor the borer... Control measures of importance have been recommended by the Dominion and Provincial Departments of Agriculture in circulars distributed amongst the growers in the infested districts in Ontario. These control measures include planting as late as is safe, early and low cutting of corn, ensiling the crop, early and careful ploughing of stubble fields followed by rolling and the proper disposal of all refuse corn stalks, weeds, etc., about the premises before the first of June.

Investigations will be continued in Ontario again this season and an effort will be made to test the value of the above control measures by an organized campaign in a definite area of the most heavily infested district.

The gradual spread of the corn borer is naturally to be expected but the value of the quarantine in preventing the wholesale shipment of infested pro-

ducts to any and all parts not already affected, is readily understood and in carrying out the regulations several infringements have already been discovered.

The confinement of the insect to the minimum area is not only important in regard to crop losses caused by it, but also in reducing the difficulty in the adoption of control measures. The only sections experiencing extreme damages thus far in Ontario have been confined to Elgin and Middlesex counties, more particularly Elgin county. In view of this a second quarantine has been placed on these two counties, which prevents the movement of products affected by the quarantine to points outside the two counties.

PLANT DISEASES OF 1921 IN QUEBEC

By B. T. Dickson, Professor of Botany, Macdonald College

The year 1921 in Quebec was typically a year of Fusarium root-rots and of mosaics.

Field peas were severely attacked by *F. lathyri*, beans by *F. martii phaseoli* and asters by *F. orthoceras*. It was difficult to grow sweet peas in any light soil owing to the heavy infection by *F. lathyri* in July and August.

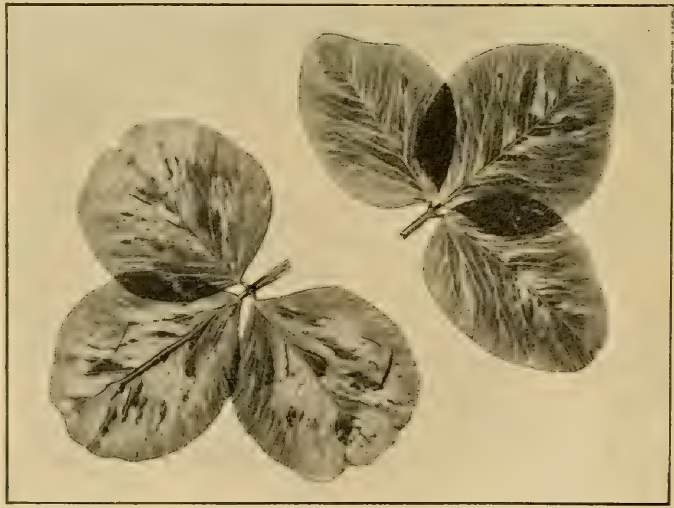


Fig. 1.—Plant diseases of 1921 Mosaic of Red Clover (T. pratense)

Fig. 2.—*Vermicularia varians* on dextrose agar, Setae well-developed

Fig. 3. — Plant diseases of 1921 *sclerotia* of *Vermicularia* on stem and inside stem

Fig. 4.— Leaf spot of rhubarb caused by *Phyllosticta straminella*. Note pycnidia at A.

Fig. 5.—Sclerotia of *Colletotrichum erumpens* grown on dextrose

Fig. 6.—Sclerotinia disease of sunflower. Fully developed sclerotia at A and young sclerotia at B.

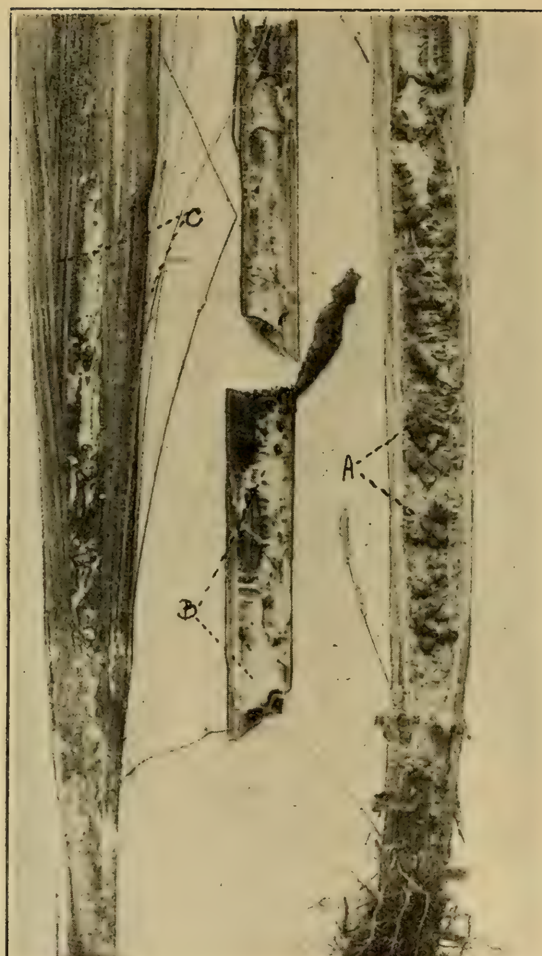


Fig. 7.—Sclerotinia disease of sunflower. Note sclerotia inside stem at A, the mycelium at B, and the effect on the tissues at C.

Mosaic was prevalent on clovers (red, crimson, alsike, white, and trefoil), on sweet clovers (white and yellow), on beans (kidney, both dwarf and pole varieties, and Windsor or broad beans), on raspberry, on tomato and tobacco, and on sweet pea. In addition the field pea (*Pisum sativum*) was determined as a new host. Hundreds of tomato fruits showed characteritic mosaic mottling and red blossoms of sweet peas exhibited a marked and rather beautiful mottling. As a result of systematic efforts on the part of Dominion and Provincial authorities mosaic of potato was not severe.

Fig. 8.—Bladderplums caused by *Exoasus pruni*. Only four plums are uninfected.

Leaf hopper burn of potato was serious in certain areas and a disease new to this continent ("Dartrose" or "Black dot disease") was discovered by the writer. This is apparently not serious and is caused by *Vermicularia varians* Ducomet. It was reported and described by Ducomet from France in 1909 and

later reported from Victoria, Australia, by McAlpine and from South Africa by Doidge.

Late blight was not noticed until about September 1st and during the warm wet period following it became pronounced. In storage during the middle and late winter, extensive rotting occurred, doubtless due to *Phytophthora infestans* in part, with *Fusarium spp.* contributing largely as a result of invasion through lesions and injuries in immature skins.

Onion smut (*Urocystis cepulæ*) was serious in one or two market gardens in the vicinity of Montreal.

Beans were affected by anthracnose but the most serious loss was caused by blight (*Ps. phaseoli*).

Sclerotinia disease of sunflower has been present during the last two seasons to a slight extent, but during 1921 it was present up to 2% in one of the experimental plots at the College.

Soft rot of cabbage, cauliflower and turnip was found in localized areas. Rhizome rot of Iris, caused by *B. carotovorus*, was present in practically every Iris bed on the Island of Montreal, and at Macdonald College it has been the major cause in the loss of some one hundred and twenty varieties during the last five years.

Rhubarb in gardens was found to be affected by *Phyllosticta straminella* causing leaf spot and *Collectotrichum erumpens* causing principally a leaf stalk rot. Both these diseases are new in Quebec and were recently described by F. L. Stevens (Bull. 213, Illinois Agricultural Experiment Station).

Peonies were slightly affected by Botrytis blight and seriously by a leaf spot disease which is being studied by Mr. Coulson of this Department.

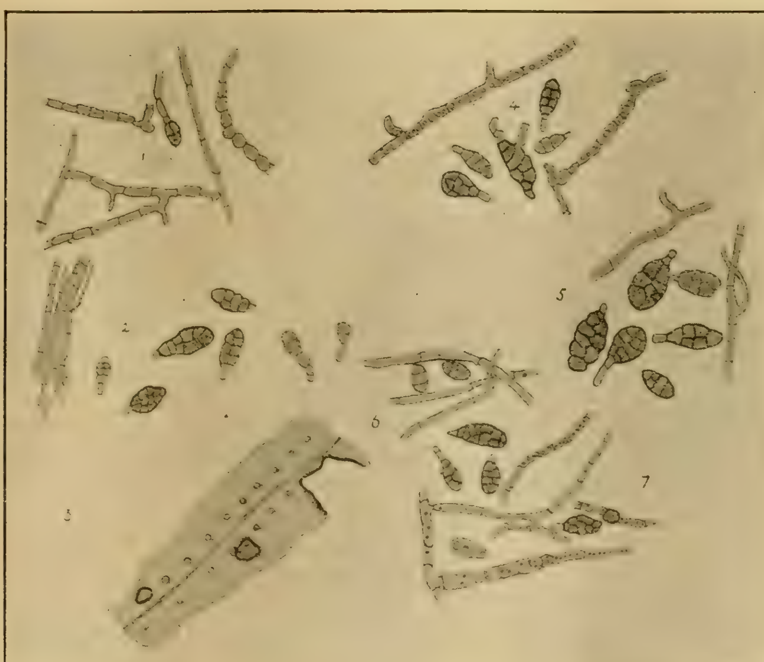
Of the fruit diseases apple scab was well controlled, black rot of apple was present in many orchards, silver leaf was present but not serious, brown rot of plums (*S. cinerea*) and bladder plums (*E. pruni*) were fairly common, and raspberry curl was severe generally.

Unfortunately it was impossible to make a detailed survey in order to determine the actual percentages of infection in the various crops but these notes indicate the chief diseases present.

AN ALTERNARIA DISEASE OF POLYPODIUM

By T. G. Major, B.S.A., M.Sc.

During the past winter the attention of the writer was drawn to a spot disease occurring on a fern (*Polypodium sp.*) in the experimental greenhouse at Macdonald College. The disease appeared to be spreading very rapidly and was ruining the plant from the decorative point of view. Since it was the only specimen of its kind in the greenhouse it was determined to carry out some experiments to ascertain the cause of the disease. The results of these experiments show that the causal organism is an *Alternaria*. The writer has not been able to find any reference in the literature to an Alternaria disease of Polypodium.



An Alternaria disease of Polypodium.

Symptoms

The lesions occur mainly on the fronds but some may also be found on the stems. They are of the typical *Alternaria* kind, brown in colour, circular to elliptic, of various sizes, occurring singly or in groups, concentrically zonate with age, irregularly scattered over the surfaces of the fronds, but mostly at the edges and tips. This last condition is probably due to the fact that the water tends to gather at the edges and serves as a favourable medium for the germination of the spores of the fungus.

Causal organism

The pathogen is a member of the Adelomycetes (1), order Moniliales, family Dematiaceæ, genus Alternaria. The writer has been unable to identify it with any species of this genus previously described and suggests tentatively the name *Alternaria polypodii* n. sp. with the following characters:—

Mycelium hyaline to light brown; conidiophores erect, simple or sparsely branched, septate, usually darker than the vegetative hyphæ, 24.5-42.5 x 1.7-4.4 u; conidia clavate, usually broadest in the middle, septate mostly transversely but also longitudinally, muriform, with long hyaline beak at the apex, catenulate, olive to dark brown in colour, measuring 24.5-70.0 x 10.5-19.25 u, (40.3 x 13.6 u).

Variation in spore sizes.—The nature of the substratum has considerable influence on spore size. To make allowance for this factor the organism was grown on iris leaf juice agar, oatmeal agar, and Richard's solution agar and careful measurements made of the spores produced on these media in addition to those occurring on the host plan. The range and average on each medium follow:

Lesions on Polypodium		31.5–70.0x10.5–19.25u (47.6x14.0 u)
Iris leaf juice agar	PH 5.9	24.5–52.5x10.5–15.75 u (36.7x13.1 u)
Oatmeal agar	PH 6.5	28.0–52.5x10.5–17.5 u (37.4x13.9 u)
Richard's solution agar	PH 5.2	31.5–52.5x10.5–17.5 u (39.5x14.3 u)

The iris leaf juice agar is an infusion of iris leaves in distilled water with 2% dextrose and 2% agar. The oatmeal agar contains 50 grams oatmeal, 20 grams agar, and 1000 cc. of distilled water The last medium was made by adding 2% agar to Richard's solution.

Pathogenicity

Isolations were made by sterilizing the outer surfaces of small bits of diseased tissue in mercuric chloride (1:1000), washing in sterile water and planting them in agar. In most cases the Alternaria described above was the only organism which developed. The hyphæ could be seen plainly growing out from the edges of the diseased tissue. Since this fact seemed to point to the pathogenicity of the organism, a number of inoculation experiments were carried out on the host plant.

A suspension of spores was sprayed, by means of an atomizer, on the fronds of the fern. Only a few minute lesions resulted and no Alternaria could be isolated from them. Believing that the lack of infection was due to unfavourable moisture conditions, measures were taken to control this factor. A young healthy frond was washed in mercuric chloride and sterile water and then enclosed

in a sterile glass chimney. A wad of absorbent cotton was soaked in sterile water insert ed in the outer end which was then clcsed with a plug of drycotton. A spore suspension was then, as before, sprayed on the frond, and the inner end of the chimney closed with absorbent cotton. Two days after inoculation numerous lesions appeared over the surface of the frond. These developed into typical spots identical with those originally found. Small bits of the diseased tissue thus produced were externally sterilized and planted in agar. The organism which developed from these lesions was found to be identical with the one first isolated, thereby completing Koch's rules of proof.

Summary

1. A hitherto unreported disease of *Polypodium sp.* has been found in the experimental greenhouse at Macdonald College.

2. It is characterized by the occurrence of brown, concentrically zoned spots on the fronds and stems.

3. The pathogen is a member of the Adelomycetes and has been tentatively named *Alternaria polypodii* n sp..

4. The conidia measure 24.5–70.0 x 10.5–19.25 u, averaging 40.3x13.6 u.

5. There is a considerable variation in spore size on different media.

6. The disease has been experimentally produced by spraying a spore suspension of *A. polypodii* on healthy, sterilized fronds.

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Illustrations

Fig. 1.—Growth on steamed rice—29 days.—PH. 6.4.
Fig. 2.—Growth on potato agar—22 days—PH. 6.8.
Fig. 3.—Habit sketch, (reduced one half).
Fig. 4.—Growth on 2% dextrose agar—79 days—PH 6.7.
Fig. 5.—Growth on Richard's solution agar—17 days—PH. 5.2.
Fig. 6.—Growth on iris leaf juice agar—10 days—PH 5.9.
Fig. 7.—Growth on iris leaf juice agar—17 days PH 5.9.
Temperature in all cases 20°C. Magnification about 330 x.

HOW WE MAY INCREASE THE EFFECTIVENESS OF ECONOMIC ENTOMOLOGY

By Geo. A. Dean, Kansas State Agricultural College

(A SYNOPSIS)

Note.—This paper was read in full at the meeting by Rev. Father Leopold, but a synopsis is given here as the paper is printed in the Journal of Economic Entomology. Feb. 1922, pp. 44-53.

As the problems of the entomologist have not only multiplied but have become more complicated during the last few years, it is very evident that

means must be taken to meet the demands of these problems. These are: "(1) fundamental training for research must be insisted upon and its importance emphasized; (2) an agreement as to which are the most fundamental problems of research and which are the most promising methods of attack must be reached, so that the available resources may be concentrated; (3) a workable plan for co-operation among entomologists, with other scientists, with public and private agencies, and with the general public must be developed and supported."

It is obvious that the economic entomologist should have a broad and fundamental training along all biological lines and many other sciences for the science of Economic Entomology is intimately related to many others. Moreover, there is a need for more organization, co-operation and co-ordination, with regard to the whole question of research; but perhaps the greatest need at the present time is a workable plan of co-operation, which should include: (a) Co-operation among entomologists themselves so that workers interested in similar problems may meet together in conference frequently and "pool resources"; (b) Co-operation between entomologists and other scientists in order that inter-relations may be more closely studied; (c) Co-operation with industrial concerns and other private agencies so that their support may be enlisted; (d) Co-operation with the public in insect control through the state, and county farm bureaus and other associations which are in intimate contact with the farmers.

To carry out such a plan of co-operation is a tremendous undertaking, but undoubtedly it can be done if the necessary organization can be brought into play. It cannot be done by one man but by a group of unselfish, optimistic and practical men imbued with the larger spirit of co-operation for the national welfare.

SOME INSECTS INJURIOUS TO SHADE TREES IN QUEBEC

By Prof. George Maheux, Provincial Entomologist

Parasitism in its widest sense is the expression of a fundamental biological law, otherwise the co-existence of so many kinds of all classes could not be possble, it seems, and keep its wonderful order; it could not keep the perfect balance of the ever-acting forces without the eternal renewal of what the inimitable Fabre calls the "le savant brigandage des êtres." The Creator is still presiding over the harmonious co-ordination of his work. In the enormous field of living things where the struggle for life knows no armistice, insects, along with microbes, play a most important part on account of their enormous numbers, their devouring activity, their marvellous vitality, and their prolificacy. There are half a million known species of insects and probably as many more to be discovered. Those who have experienced the power of destruction of these little animals cannot ignore their power as agents of disintegration in the world.

In their destructive rage insects attack both animals and plants, and as many of these are in some way useful to man, insects are arrayed against man

in a great struggle. Directly or indirectly man suffers from their attacks. On the one hand, lice, fleas and some mites live as real parasites upon man; flies, mosquitoes and other unwelcome guests of our dwellings carry germs of infective diseases. On the other hand, everything that is useful or necessary to man suffers from continual attacks from scores of insects; animals reared for his living or help live under perpetual menace of attack; vegetables, cereals and fruits so indispensable to life, trees giving beauty, shade and various products, in a word, all plants seem to be choice dishes for noxious insects. Damages run up into millions of dollars yearly in this province alone.

A study of the noxious insects of plants would be a long and arduous task and would over-run the limits of this paper. In fact it would be a long task to review the insects injurious to trees, therefore we will attempt only to outline the life histories of the more important injurious species on shade trees.

Insects naturally fall into two groups—external and internal feeders. The external feeders include caterpillars, plant lice and scale insects. Norwithstanding appearances insects of this group are not, generally speaking, the most dangerous enemies of trees. Even if a tree be defoliated it possesses the power of recuperation and, in nearly every case, will succeed in putting out new leaves, sooner or later according to its power of resistance, without much appreciable loss. It is quite rare to find a maple, an elm, a poplar or an oak die immediately after the premature disappearance of its leaves due to animal agency. Death follows only after intensive defoliation for three or four years in succession. However, scourges of insects and caterpillars manifest themselves usually with virulence only for three years and return periodically every eight, ten, twelve or fifteen years, or more frequently according to the species. Between two consecutive attaks where there has been much damage, the depredations of a leaf-eating insect can be represented by a curve, the highest points being the years of the epidemic, gradually becoming lower to the minimum which would coincide with the middle period of control, and gradually ascending again little by little; the natural enemies of the insects aiding artificial agents tend to combat them. The tree will then show every chance of surviving the assaults of the insect and of returning to the condition before it was attacked.

Like resistance is not met with among the resin producing trees—which generally show a very great susceptibility. This is due to their inability to make rapidly new foliage, little accustomed to annual renewals and to a physiological weakness belonging to an organism incapable of recovering from agencies that make for a lessening of its power. Even with essential oils conifers deprived of foliage show this characteristic weakness. One example will suffice. Canada balsam was practically wanting in our province at the close of the last century—caused by the repeated ravages of the Larch Saw Fly (*Nematus Erichsonii*). Its migration westward is due to a scarcity of victims rather than a pronounced desire for adventures.

This introduction, dealing with a few examples of leafeaters is a little long, nevertheless necessary. I shall confine myself to the species which have ac-

quired a bad reputation in the City of Quebec and the surrounding district. Of these defoliators principal mention will be made of the Tent Caterpillars, the Elm Caterpillar, and the White marked Tussock Moth.

The Tent Caterpillars (*Malocosoma americana and M. disstria*).

In 1912 countless armies of tent caterpillars completely stripped the maples and other trees that were objects of pride in the parks and along the highways. Two sister species belonging to the Lasiocampidæ family, worked concertedly—the American and the Forest caterpillars. They are very similar in habits, the first, however, preferring the apple, the second the forest trees, but both feeding upon succulent foliage of all kinds when they occur in large numbers in the same locality. It should be added that the Forest Caterpillar, in spite of its comonm name does not build a tent.

The life history of these two insects may be summarized as follows: they winter as eggs arranged as large rings, each containing 150-300 shells, around the smaller branches of the trees selected by the females for egg-laying. At the end of May or about the beginning of June, the eggs hatch and the little caterpillars make for the leaves in quest of food. The true tent caterpillars live in colonies in a sort of house made of threads secreted by the larvæ, situated at the crotch of two branches, and capable of sheltering 100-250 caterpillars.

The other species has only the power of making a silk thread wherever it goes. Up to the 15th or 20th of June the trees are either partially or wholly defoliated, according to the number of caterpillars that are working. At this time the caterpillars are about two inches long and are fully grown. They then leave the host plant and wander here and there until they find a suitable hiding place. There they form a cocoon of whitish silk within which they make their transformation to a pupa. Ten or fifteen days later, moths emerge from the cocoons. In the first days of July mating and egg-laying occur; at that time myriads of the moths can be seen flying about the lamps of our cities. The reproduction of the species having been assured the mission of the adult insect is ended and it dies. The eggs are the only evidence of life until the following spring.

The Elm Caterpillar (*Vanessa autiopa L.*)

The Elm Caterpillar belongs to the Nymphalidæ family of the Lepidoptera. It is a black caterpillar marked with chestnut spots and bearing a cuirass of long forked spines. We have found it quite numerous on the elms cf the city of Quebec during the last five years. The leaves of the elm are its favorite food and it gets nourishment from them in a strange way. The green portion filled with chlorphyll is very appetizing, for after the visit there remains only a skeleton of veins covering the upper epidermis which has remained intact and become transparent, the whole assuming a yellow color.

The caterpillar does not appear until the last half of July, and it requires four weeks to attain full growth. It is then two inches long and it roams about at random seeking a suitable place in which to transform to a chrysalis. Unable to spin a cocoon it adopts the very simple procedure of suspending itself by the

abdominal extremity with the help of some threads. Soon occurs the definite moulting by which the larval skin is discarded for the narrow swaddling clothes of the pupa. Fifteen days later (August 20th—September 15th) emerges a beautiful butterfly which winters in the adult state snugly under some shelter. In the first fine days of spring the butterfly takes to flight, and deposits its eggs in long slender plates on the small branches of the elm, willow and poplar.

The White marked Tussock Caterpillar. (*Hemerocampa leucostigma*).

During the last few years the poplars, willows and climbers in many parts of the province and particularly in the cities of Quebec and Montreal have been defoliated by this caterpillar. It gets its name from the four whitish, hairy and thick-set tufts on its back. In other respects it is richly adorned with dark yellow stripes along its surface, with a red head and with two black plumes at the front and one at the rear; it is a very pretty creature. August is usually the period of larval activity, and it devours quickly all the leaves of a tree. The yellowish cocoon is attached to the bark of the trunk and branches. The wingless female does not depart very far from the cocoon but attaches herself closely to it, its mission being to lay its eggs on this silky mass. The eggs are covered by a white, frothy substance which hardens on exposure to the air and becomes a very effective protector. The male is a beautiful moth with superb wings and strongly pectinated antennæ. This species belongs to the Liparidæ family of the Lepidoptera.

So much for the first group. We shall now examine some wood-eating types that bore into wood or between the bark and the wood. The makers of tunnels under the bark are the worst enemies of trees, and for that reason they have been named "ravageurs" or Borers. From the physiological and commercial standpoint the damage done by these insects are often irremediable.

If the gnawing larvæ in any one tree be at all numerous the galleries or tunnels increase and intercross on the entire periphery of the woody cylinder. Their complex system interferes with the movement of sap in the tree and especially with the downward movement of the elaborated sap which cannot pass below the injured region.

The Sugar Maple Borer (*Plagionotus speciosus*).

This is a beautiful beetle belonging to the Cerambycidae family of the Coleoptera. The body of the adult is marked with different designs in yellow. The eggs are deposited in the bark of the maple, and several days later a pale larva, without feet, hatches out and makes its way towards the sap-wood boring its way like a gimlet. Here it digs a canal which keeps enlarging with the development of the larva which takes two years. Now at its full development the larva digs out a chamber for the pupa at the approach of winter close to the corky tissue. The following summer the newly hatched adult has only to break through the thin covering of bark to get free. It is seldom that we find more than two larvae working at the same time on the same tree. Since the tunnels are horizontal for only about one half to two-thirds of their entire length with

the remainder vertical, some of the cortical surface dries up and falls leaving bare the adjacent ligneous layers. Nevertheless the tree may continue to live.

The Bronze Birch Borer (*Agrilus anxius* Gory.)

This borer belonging to the Buprestidæ family of the Coleoptera is a scourge but recently established in Quebec. During the past seven years, numerous cut leaf birches, very handsome trees, have been killed by this insect. Unlike the sugar maple borer, the larvæ of this pest appear in large numbers on a single tree, and their numerous burrows completely cover the trunk with a labyrinth of tunnels. The small pale larva lives but one year and the following spring the adult leaves the tree by an elliptical opening. This adult is a small bronze black, cylindrical insect. It is safe to say that a birch when once infested with this borer is bound to die within two or three years.

The Poplar Borer (*Saperda calcarata* Say).

Although less decorative than the birch, the species of the Populus are widely planted here as ornamental trees. They are unfortunately the victim of many diseases of fungous and insect pests of which the Saperda is one of the most important. The larva is thick and fat and bores its tunnels vertically right in the sap wood. These are like gimlet holes and are filled with coarsely torn fibres and woody particles with which the larva surrounds itself at the time of metamorphosis. Since it grows for three years constantly increasing in size, the burrow becomes very wide and causes serious derangement in the life and growth of the tree. The adult is a beautiful insect covered with a greyish down, sometimes colored with brown or yellow. The insect belongs to the Cerambycidæ family of the Coleoptera.

Poplar and Willow Borer. (*Cryptorhynchus lapathi*).

This insect was practically unknown here ten years ago but is found now in several places. As to its origin there seems to be no doubt that this wood borer was introduced from Ontario and is still coming in with plants imported from that province. It attacks with preference Carolina Poplars which succumb to its depredation a year after they are planted. The larvæ bore into the young trunk in several places and kill the outside portion, but fortunately the poplar rebuilds new tissue from the base of the trunk.

The larva is pale and fleshy. The adult has a rather small body, black in color, with the extremities of the wings greyish and sometimes pink.

Conclusion

We can only preserve our ornamental trees intact by exercising the necessary precautions. Essential measures consist in keeping the trees tidy, the removing of the diseased portions and the cleaning of the bark. In case of an epidemic of caterpillars the tree may be preserved by the timely application of arsenical solutions. Wood borers may be easily exterminated with carbon bisulphide. Finally, in the spring and fall, eggs, cocoons, etc. should be collected

and immediately burnt. Gummed bands applied to the trunk will protect the tree very effectively against many marauders from outside especially caterpillars.

The measures outlined above should help to prolong the beauty of our ornamental trees.

DISEASES OF THE POTATO *

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Introduction

The potato crop is of prime importance to Canada and therefore the importance of a knowledge of the diseases of the potato need not be stressed here—it should be taken for granted. Without quoting statistics, the losses from potato diseases amount to millions of dollars every year. This means that every year a percentage of the seed planted is useless, that a part of every acreage is wasted, that labor is not used to full advantage and, finally, that the grower suffers a direct financial loss whether he is growing potatoes for sale or use.

In dealing with this series the diseases will be considered in the order now given.

1. Diseases in which insects are the agents of infection or in which insects are the direct cause:—
    (a) Hopperburn.
    (b) Mosaic and mosaic dwarf.
    (c) Leaf roll.

2.—Disease caused by a myxomycete:—
    (a)— Powdery scab (*Spongospora subterranea*).

3.—Disease caused by bacteria:—
    (a) Black leg (*Bacillus atrosepticus.*)

4.—Diseases caused by Phycomycetes:—
    (a) Black wart or potato canker (*Chrysophlyctis endobiotica.*)
    (b) Leak (*Pythium de baryanum*).
    (c) Late blight (*Phytophthora infestans*).

5.—Disease caused by an Ascomycete:—
    (a) Wilt and stem rot (*Sclerotinia libertiana.*)

6.—Disease caused by a Basidiomycete:
    (a) Dry stem rot and black scurf (*Corticium vagum*).

7.—Diseases caused by Fungi imperfecti:
    (a) Early blight (*Alternaria solani*).
    (b) Wilt (*Fusarium oxysporum*).

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(c) Common scab (*Actinomyces scabies.*)
(d) Skin spot (*Oospora pustulans*).
(e) Silver scurf (*Spondylocladium atrovirens*).
(f) Dry rot of tubers (*Fusarium spp*)
(g) Fusarium net-necrosis (*F.oxysporum*).
(h) Black dot disease (*Vermicularia varians*).

8. Diseases caused by conditions which adversely affect the normal physiological processes:
(a) Black heart.
(b) Frost necrosis.
(c) Net necrosis.
(d) Internal brown spot.
(e) Spindling sprout.
(f) Hollow heart.
(g) Arsenical injury.

9. General considerations in control.

It will thus be seen that there are some twenty or more common potat diseases with which the growers may have to contend at different seasons.

GROUP 1.

In this group are placed three (or four) diseases in which insects play an important role.

(a) *Hopperburn,* or "tipburn" as it used to be called, occurs periodically whenever dry conditions prevail in potato growing areas. It was noted first in Iowa in 1876 by Osborn, but wilting of early varieties was the most pronounced characteristic. Osborn recorded the presence on such diseased plants of *Empoasca Mali* (Le Baron) known as the leafhopper. In 1908 its work was observed in New York, and again in 1909. Fraser reported it from Quebec in 1913, it was again serious in Iowa in 1915, and in Vermont in 1917. Ball in Wisconsin, in 1918, studied the disease which that year extended from Montana and Kansas to New York and New Jersey. This year the leafhopper was very prevalent in Quebec and hopperburn is certain to have caused considerable loss (1921).

Symptoms of the Disease

The first signs of the hopperburn usually appear during the latter part of July or early in August with most severe effects from the middle of August to the middle of September. On some of the lower leaves a slight yellowing begins at the tip or edge of terminal leaflets. As the injury progresses the yellow areas become brown, curl up and dry out. Thus the leaflet finally possesses a dark-brown, dried, uprolled margin with a band of green in the middle bordering the midrid (see plate). The remaining leaflets gradually become affected so that the whole leaf is involved (plate). When the season is hot and dry such leaves shrivel completely, the petiole gradually dries towards the stem and hangs limp so that a touch will cause it to drop. Whole fields may succumb to this injury

in a period of two dry hot, weeks so that a "burned over" appearance is given to the crop. Usually, however, the upper, young parts of the plants escape burning for a time owing to the fact that the adult females prefer young growing tissues for oviposition. It is not until the eggs hatch and the nymphs begin to feed that injury is noticeable in these parts. The nymphs, because they do not migrate rapidly, are restricted in their feeding to the area in which they were hatched, consequently causing severe injury in that area. Adults, on the other hand, fly at the slightest disturbance and thus their effect is more distributed.

During cool moist weather the burning is checked and this also applies to plants which have been sprayed with Bordeaux.

Effect on Plant

The eggs are laid on the midrib and petiole of the potato leaf and when hatched the nymphs feed mostly by sucking juice from the larger veins in the upper part of each leaflet. This reduces the supply of sap for the smaller veins at the margin and tip of the leaflets and accounts for the fact that browning, rolling and drying out occur at the tip and margin. There is thus a direct loss of sap from the leaves followed by the death of large areas of leaf tissue. This occurs at the time when maximum growth rate of tubers should occur. Consequently the tubers suffer and the greater the area of foliage affected the more severe the effect on the tubers. In cases where defoliation is complete, or nearly so, the crop is a total loss.

Other Hosts

Field observations show that this insect may live temporarily on many hosts among which are: bean, apple, beet, rhubarb, raspberry, red clover, Swiss chard, strawberry, cucumber, lettuce, dahlia, hollyhock, elm, box-elder, burdock, rose, etc.

On some of the above the leaf-hopper merely feeds, but on beet, apple, beans and box-elder it will also reproduce.

Life History

The potato leafhopper (*E. Mali*) lives over winter in the adult stage in protected places such as among thickly growing weeds, in brush, etc. In June they come out from their resting place and feed for ten days or so on the apple and other trees and shrubs, and at this time females predominate. At the end

of the feeding period they migrate to potatoes and beans and begin mating and egg laying.

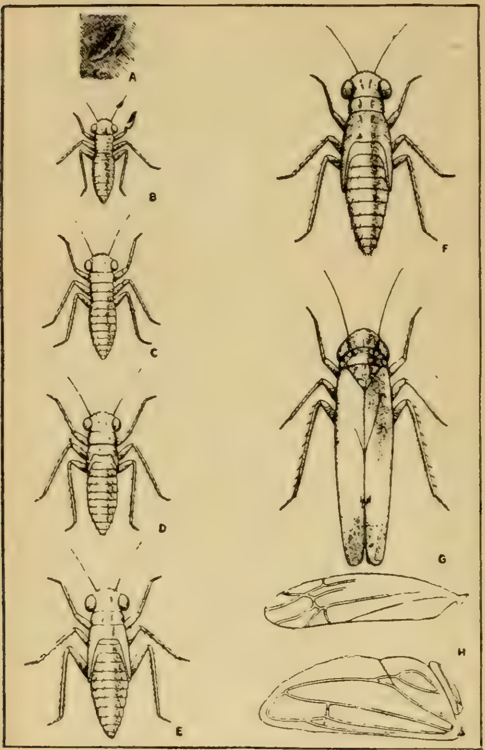

Fig. 1 THE POTATO LEAFHOPPER.—A. Egg in leaf tissue; B. First nymphal stage; C. Second stage; D. Third stage; E. Fourth stage; F. Fifth stage; G. Adult stage; H. Outer (elytron) and inner wing, showing venation. After Bull, 334, Wisconsin University Agr. Exp. Sta.

The eggs are about $^1/_{30}$ of an inch long and are transparent at first. They are deposited in the petiole and midribs of leaves where they change from transparent white to yellow. In from ten days to two weeks the eggs hatch and the young nymphs appear as whitish, wingless hoppers. They begin to feed at once and as they absorb the plant juice they grow and become green. They shed the skin five times during their growing season and become winged adults in about seventeen days. When quite young they are to be found mostly on the lower side of the leaves and they move about but little.

The adult females have a long egg laying period and nymphs in all stages may be found up to the time of the first frost.

The first generation of the season causes the first noticed hopperburn on the potatoes. Adult females of this generation give rise to a second generation during the season and usually the severest attack of hopperburn occurs at the period when adults of the first generation and nymphs of the second generation are feeding at the same time. The over—wintering leaf hoppers are members of the second generation.

Varietal Susceptibility

In Quebec the Irish Cobbler appears to be more susceptible to leaf hopperburn than Green Mountain. Unfortunately the writer does not happen to have at the present moment facts relative to susceptibility for other potato growing areas of Canada. In Wisconsin Early Triumph is affected worst and Rural New Yorker least. An important point to notice is that early planted potatoes are liable to suffer more from hopperburn than late planted varieties. It is also

significant that plants from seed of diseased vines always suffer more severely than plants from seed of healthy vines.

Control

Spraying with Bordeaux 4-4-50 is effective in controlling hopperburn provided that the underside of the leaves is sprayed thoroughly. This is obvious when considering the fact that nymphs feed on the underside of leaves as above noted.

(b) *Mosaic and Mosaic Dwarf.*

W. A. Orton first described Mosaic as a disease of potatoes from observations he made in potato fields at Giessen while visiting in Germany, although Quanjer believes that the disease has been known for a long time in Europe. Orton on his return found the disease to be quite prevalent in Maine in the Green Mountain variety. This was in 1912 and since that time the disease has been found in practically every potato-growing area of the United States and Canada.

The cause of the disease is not yet determined, although it is certainly a systemic disease, and it has been placed here in Group 1 because of the established fact that aphids are agents of inoculation.

While the disease may be regarded as new, as compared with Late Blight for instance, it is highly infectious and has spread with alarming rapidity. In 1919 careful estimates made in Aroostook County, Maine, of 40 fields of Green Mountain and the same number of Bliss Triumph showed an average of 28 per cent of infected hills of Green Mountain and 46 per cent in the case of Bliss Triumph. In some cases the diseased plants amounted to 100 per cent. It is therefore of paramount importance that efforts be continually made to check the spread of this insidious disease. The difficulty involved lies in the fact that the potato tuber, a vegetative part of the plant, is used for seed purposes and the causal principle may be present in the tubers as a result of late infection without there being distinct signs of the disease in the foliage.

Symptoms of the Disease

The disease may manifest itself in either of two ways according to the variety or according to the locality. The typical symptom from which the name arose is the mottling of the foliage. Lighter green areas occur in the leaves and these lighter green areas may be few or numerous, they may be very small or reach the size of a quarter of an inch, and in shape are usually angular. The leaflets may also be more or less ruffled or wrinkled owing to the modified growth, and where this is the case the wrinkles are likely to obscure the mottling at first

sight. The above symptoms are typical for Green Mountain potatoes. It might be added for those readers who have at their disposal a microscope that a thin freehand section through a light green area bordered with the dark green will show, even under the low power, that in the light part the palisade tissue has not been able to develop normally. The cells instead of being from four to six times as long as wide are approximately cubical or distinctly shorter.

Fig. 2—Plant A is healthy. Plant B is suffering with mosaic. Note at 1 the scars left by fallen leaves and at 2 a leaf which has just dropped.

The Irish Cobbler, on the other hand, exhibits different characteristics. Here mottling is not usual but instead the leaves of affected plants are extremely wrinkled and dwarfed. The leaflets are smaller, the petioles are reduced and even the haulms are dwarfed This gives rise to a type known as *Curly Dwarf* in extreme cases. The Rural varieties also show this group of symptoms.

With regard to locality it is interesting to note that with the same variety the symptoms differ according to whether the variety is planted in a northerly or cooler district, or in a more southerly, warmer place. In the cooler locality mottling is pronounced whereas in the southerly, warmer district mottling is reduced or altogether obscured. That the plants are still diseased, however, is proved by the fact that if tubers from a plant grown under the latter conditions be planted further north mottling is again pronounced.

In addition to the above symptoms it is to be noticed that plants severely affected with mosaic will show this in weaker stem development and in a generally unthrifty condition.

Effect on the Plant

One effect of the disease has already been mentioned, namely the modified growth of the palisade cells in light green areas. Other cells are affected to a less noticeable extent but the general effect is that the tissues which should be manufacturing a maximum amount of starch are not able to do so, and further a proportion of that manufactured is undoubtedly used by the causal principle. This is postulating that the causal principle is a parasite. Hence the amount of food

available for tuber formation is reduced according to the severity of the disease and the duration of it in the particular plants. The tubers are therefore reduced in size or in number, or both. In the case of late infection there is not likely to be any noticeable difference in the tubers. Murphy has estimated that severely diseased plants yield only 57.8 per cent of a crop as compared with healthy plants of the same variety under the same cultural conditions.

Infection

Gussow has shown that by grafting the disease may be readily transmitted, and Folsom *et al.* have obtained similar results in Maine. The writer in unpublished work has found aphids to be fertile sources of infection, and Folsom et al. have carried on extensive experiments in Maine proving clearly that plant lice, (*Myzus persicæ* Sulz. and *Macrosiphum solanifolii* Ashmead) are carriers of the disease from plant to plant. The writer has found that aphids are also most important in the transmission of clover mosaic and it is probable that they play a part in most mosaic diseases.

Other potato pests, such as the Colorado potato beetle and the flea beetle, are not found to be carriers of the disease.

Experiments also indicate that the seed cutting knife is not important in transmitting the disease. The same applies to contact in the field between healthy and diseased plants. Soil has not been found to transmit the disease from one season to the next, but it may be possible that volunteer plants arising from diseased tubers left in the soil will give rise to centres of infection the following season.

Fig. 3—A leaf of potato showing mosaic mottling. Note at 1 a flea-beetle hole and at 2 a typical light green area.

Varietal Susceptibility

Little is yet known of this phase of the question and work on it is difficult because of the carrying over of diseased tubers which came from apparently healthy plants. It is known, however, that on the whole the Irish Cobbler variety is less susceptible to the disease while Green Mountain is particularly susceptible.

Control

Three points in control are empha-

sized. If the grower prefers to use his own seed the seed plot should be isolated from other potato patches in order to reduce the possibility of infection by means of aphids. It follows that the seed tubers used should be healthy as far as it is possible to ascertain this fact. If diseased plants are observed they should be rogued at once and if aphids are seen on the diseased plants when rogued a careful inspection should be made of the plants immediately surrounding. Any plants upon which aphids are found should also be removed. Finally, since aphids are the prime carriers of the infective principle it is necessary to control plant lice. To accomplish this, add ¾ of a pint of "Black Leaf 40" to every 50 gallons of Bordeaux mixture and spray to cover both the upper and under sides of the leaves.

Before leaving the subject of mosaic, mention should be made of a peculiar condition found in severely diseased plants by Gussow and also by the present writer. In the leaves small, angular areas suddenly become brownish and necrotic. In the petioles brown streaks appear just below the epidermis and later similar lesions develop in the stem. Soon after the lesions appear the petiole collapses and the leaf withers, hanging by a mere thread. It then falls and as the whole plant is rapidly affected a very characteristic appearance is given. This is shown in Plate 3 plant B. It cannot be stated for certain that this is a type of severe mosaic, but the writer has not observed similar conditions in other than mosaic diseased plants of the Green Mountain variety.

(*c*) *Potato Leaf roll.*

The disease known as "*Leaf roll*" is, like mosaic, comparatively new and in many respect it resembles mosaic. It is infectious, is transmitted by plant lice, it is systemic, and is controlled in the same way.

Symptoms of the disease

The name suggests the outstanding symptom but care must be exercised in differentiating the rolling of the leaves in this disease from rolling in wilt diseases and in cases of either excessive moisture or continued drought. In true leaf roll the leaflets are distinctly rigid and not in the least wilted. They are uprolled so that the two margins tend to come together forming a trough like structure. They are lighter green than normal leaves and in severe cases of the disease they may be yellowish, reddish or purplish. The plants are dwarfed having shorter petioles and haulms than normal, and the whole plant has a typical aspect owing to the angle of development of the petioles. Instead of being rather spreading as in a healthy plant the leaves and branches tend to assume an angle of approximately 45 degrees from the main stem. The stolons bearing

tubers are considerably shortened and the tubers are smaller, fewer, and are conspicuously harder than tubers from healthy plants. This hardness of the tubers is maintained even for considerable periods in storage.

Fig. 4—A leaf showing the dwarf, curled, dark green symptoms of mosaic. There are no apparent light green patches.

The rolling usually appears in the lower leaves first but a late infection may affect only the leaves last developed.

Effect on the Plant

As with mosaic the leaves of potatoes suffering from leaf roll do not function properly. The causal principle is translocated in the plant juices and in this case it especially affects that part of the vascular tissues known as the phloem. In the phloem it gives rise to a necrosis or death of the tissue. Since it is in the phloem that most of the conduction of elaborated food takes place, those parts awaiting supplies of food for their development will receive only a much reduced amount. This is the case with the tubers and the stolons bearing the tubers. Hence those tubers which do develop are small and are borne on short underground stems. Moreover the infective principle passes down the parts of the phloem not killed and reaches the vascular tissues of the developing tuber. In it, therefore, there may also be phloem-necrosis. When such a tuber is cut across, or when it is pared to expose the vascular tissues, these are seen to be browned. The general term "*net-necrosis*" is used to indicate such an appearance, but it must be recollected that net-necrosis may be caused by other conditions than those in leaf-roll. Moreover the tubers from a plant with leaf-roll do not necessarily develop net-necrosis, for they may not be affected soon enough, nor sufficiently severely, to cause necrosis in the vascular tissues. A further effect on the plant is exhibited in the next generation for tubers from diseased plants, and especially those with net-necrosis, frequently develop very weak, spindling sprouts.

The yield from leaf-roll plants is materially reduced, in many cases being nothing at all.

Infection

The tubers transmit the disease as in the case of mosaic, but an additional fact must be mentioned, namely, that in the progeny of plants with leaf-roll there is a much more rapid depreciation in yield and accentuation of the disease than is the case with mosaic.

Tests conducted in Maine show that aphids again are the only insects of importance in transmitting leaf-roll. The seed-cutting knife is not a factor in the spread of the disease.

Varietal Susceptibility

Red varieties are usually more susceptible than white varieties. Garnet Chili, Davies Warrior, Irish Cobbler, Early Puritan, Early Six Weeks, Dakota Red and McIntyre develop the disease more severely than Carman, Green Mountain, and Empire State. The last named at times appears to be free and at others is severely affected, due in all probability to lack of inoculation by aphids.

Control

The same points mentioned for the control of mosaic apply to the control of leaf-roll.

GROUP 2.

Diseases caused by Myxomycetes or Slime Moulds

There are certain organisms which have not yet been definitely assigned to the animal kingdom nor to the plant kingdom, because during part of the life history they move, feed and grow in such a manner that they are more animal like than plant like, while the reverse is the case at reproduction time. Such organisms are known as "Myxomycetes" and usually they are saprophytic. Two, however, are parasites causing diseases of considerable economic importance, viz., "Club root" of cabbage, cauliflower, brocoli etc., and "Powdery scab" or "Corky scab" of potato. This latter disease is caused by a slime mould known as *Spongospora subterranea* (Wallr.) Johnson.

Powdery Scab or Corky Scab (*Spongospora subterranea*)

Occurrence

The disease has been known in Europe for nearly eighty years being described first by Wallroth in 1842 and it was noted by Barkeley in 1846 in England. The former investigator, however, considered that the disease was a smut.

Brunchorst, in Norway, in 1886 studied the disease and named the causal organism *Spongospora,* placing it among the Myxomycetes. Gussow was the first to find the disease on this continent, some potatoes with typical scab spots being sent to him from several localities in Canada in 1912. Morse and Melhus then found evidence of the existence of the disease in Maine in the summer of 1913. It is now known to be present in Great Britain, Ireland, Northern and Central Europe, South America, Eastern Canada and in several northern localities of the United States of which the most important was Maine. Dr. Morse, Director of the Maine Station, has informed the writer in correspondence that Powdery Scab has not been found to any extent during the last five or six years in Maine. That a similar situation occurs in New Brunswick is borne out by correspondence between Dr. Morse, Mr. Cunningham and the writer.

Symptoms

The name of the causal organism indicates that only underground parts are attacked, namely roots, stolons and tubers. Roots are affected earlier in the season and on them white galls develop, looking remarkably like the nodules on the roots of leguminous plants. Similar galls are produced on the stolons and less commonly on the part of the stem underground. Roots of all ages may be affected.

On the tuber the pustules begin to appear a little later in the season, usually when the potatoes are already of a fair size. The stem end is frequently first affected but as the tuber matures pustules may be found anywhere on the surface.

The first sign is a tiny, brownish purple pimple on the surface surrounded by a more or less translucent zone, the whole not exceeding one twelfth of an inch in diameter. This spot increases in size and the skin is gradually separated from the tissues below, which are stimulated to abnormal growth so that the protuberance is formed. Usually the epidermis is ruptured by this growth just about the time the organism is ready to go into the spore stage. The turned-back epidermis is typical of the pustules of powdery scab in uninjured specimens. As the parasite matures the host cells are invaded, broken down and killed so that only remnants are found. At this time the parasite ceases its vegetative life and forms spores which are aggregated into balls. It is the spore balls together with remnants of cellular tissues which form the powdery mass found in the pustules at maturity and which account for the common name "Powdery Scab". If one rubs out the powdery mass the tissue below is seen to resemble the epidermis of the tuber to a certain extent and in fact there is present a layer of cells functioning as a cork layer, which fact accounts for the other common name for the disease—"Corky Scab".

In Europe, Great Britain and Ireland, a more advanced stage of the disease is found where the tuber as a whole is malformed and tissues severely disorganized, this is known as the canker stage. That it does not occur in this country is probably due to the shorter growing season.

Life History

Spongospora subterranea requires an abundant supply of moisture for germination, as well as warmth. Hence it is that the disease is more serious in poorly drained soils or during highly humid seasons. The spores in the spore ball germinate giving rise eventually to naked masses of protoplasm known as "plasmodia". A plasmodium moves slowly over a surface which is moist by means of pseudopodia which are merely protrusions of the naked protoplasm. In this way, by moving in soil water among the interstices of the soil, the plasmodia reach roots, stolons and tubers. Whichever the part attacked, the plasmodium penetrates the epidermis and gradually passes down to the cells below. These are stimulated to excessive growth so that "giant cells" are formed which may also divide, thus giving an abnormal number of cells in the tissue and accounting for the gall formation on root and stolon and the protuberance on the tuber. In root and stolon galls the parasite eventually reaches the phloem in which most of the food manufactured is conducted and in this tissue most of the hypertrophy occurs. The tuber is somewhat modified because of its function as a large storage organ and the plasmodia do not, as a rule, reach the phloem but attack cells of the hypodermis and cortex.

Fig. 5—Roots of potato with galls caused by Spongospora subterranea

Where a cell is covered by a plasmodium or part of one, the wall swells and softens. That it is changed chemically is shown by the modified staining. Through the softened wall the plasmodium penetrates by protoplasmic protrusions which Kunkel calls "infecting pseudopodia". Once inside the cell, the naked protoplasm of the myxomycete penetrates the limiting membrane of the host protoplast and the two protoplasms are to an extent miscible. It is when the cell is thus infected that hypertrophy begins. As the vegetative growth of the potato gradually ceases and maturation commences the spores of *Spongospora subterranea* are formed and these spores are aggregated into round masses known as spore balls. Such groups of spores are highly resistant

to adverse conditions and are known to be able to live over in the soil at least three years.

Fig. 6—Black-stem of potato. Note the blackened tissues at A and also the rolling of the leaves. (After Coons, Mich. Bull. 85; Fig. 7 also.)

Before leaving this discussion mention should be made of dry rots following *S. subterranea.* If, in the development of the pustule, it happens that the cork layer which cuts off the parasite is not laid down, drying-out or dessication follows in storage. The severity of this depends upon the number of pustules on the surface of the tubers which are not limited by a cork layer. It often happens that the spore balls are still present in the pustule in storage and if the temperature conditions are satisfactory for germination, the spores in the balls will germinate and the resulting plasmodia will destroy cells surrounding the old pustule.

Naturally such pustules are open places for the entrance of wound parasites and one of the most important of these, *Phoma tuberosa* Melhus et al, causes serious dry-rot injury.

It must be pointed out that, secondary Spongospora injury, dry-rot and dessication may occur together in some cases.

Varietal Susceptibility

Nothing can yet be said regarding resistance to this disease since it is probable that all the well-known potato varieties may be affected. Seasonal differences may account for some varieties escaping infection during one season but being affected another.

Other Hosts

It is interesting to note that the roots of tomato are susceptible to infection by *S. subterranea* and that galls are formed similar to those on potato roots.

Control

The following points are important in control:

1. Seed tuber selection.
2. Seed tuber treatment (formaldehyde, hot or cold).
3. Destruction of spore balls in diseased tubers by boiling before using as feed.
4. Sulphur 900 lbs. per acre applied broadcast reduces the amount of infection.
5. Practise long rotation if the attack is severe.

Skin spot

"Skin spot" caused by *Oospora pustulans* is placed among the diseases caused by Fungi imperfecti. Potatoes with a spot apparently exactly like that caused by *O. pustulans*, as described in England, were found in shipments to the Spokane market from British Columbia. In fact Heald found that 95 per cent of the tubers showed lesions. The spots are circular, brown and small when young, darkening with age. At first the spots appear slightly elevated but later somewhat depressed. Under moist conditions sporulation and growth occur in the lesions so that further necrosis occurs. Shapovalov, in a paper given at the Toronto meeting of the American Phytopathological Society, states that the pustules are identical with those of the immature or closed-sorus stage of powdery scab. This author investigated the fungi which, as secondary organisms, invade the "skin-spot" pustules and found that they varied with the locality.

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GROUP 3.

DISEASES CAUSED BY BACTERIA

Black-leg or Black stem-rot

(*B. atrosepticus v. Hall*).

The most important disease of potatoes caused by bacteria is that known commonly as "Black-leg". Other names are:— "Basal stem rot", "Bacterial black rot", "Black shank disease", "Black stem-rot". It is obvious that "Black leg" is an unfortunate name and that "Black stem-rot" or "Bacterial black rot" would be preferable. Throughout the course of this discussion, the name used will be "Black stem-rot".

Occurrence

Black stem-rot of potatoes occurs in Northern and Central Europe, Great Britain, Ireland, Canada and the United States. Its economic importance varies with the season, being pronounced in moist, cool seasons. Murphy states that, in 1915, 7 p.c. of the crop in New Brunswick and 10 p. c. in Nova Scotia and Prince Edward Island were destroyed by this disease. In Ontario still greater losses occur in years suitable meteorologically. A black stem-rot of potatoes was described first in America by Harrison in 1906.

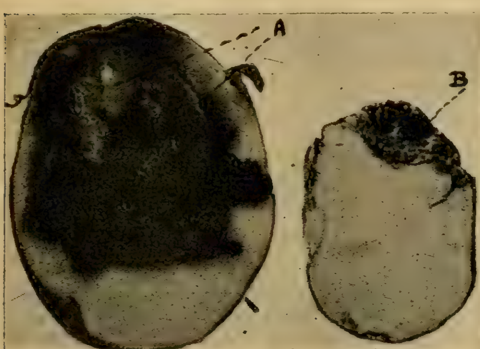

Fig. 7—Rot of tubers caused by the blackstem organism. Note at A the canals with creamy bac- the terial slime. Note at B the stemend rot of tuber.

Symptoms

Infected plants usually begin to show late in June or early in July and are quite prominent by the middle to the end of July. Such plants are somewhat dwarfed, although not necessarily markedly so, and their leaves are pale or yellowish. Rolling of the leaflets along the midrib, somewhat as in true Leafroll, occurs but it can be distinguished by the fact that the leaflets are not rigid and brittle. If the infection happens to occur after the plant has grown considerably, and if the infection also happens to progress rapidly because of suitable humidity and temperature, the growth of the upper part of the plant will be suddenly checked. Thus internodes are shortened and leaves considerably dwarfed giving rise to a "rosette" top. If the attack is still more sudden and severe the stem may wilt suddenly and fall over without previous symptoms other than the flaccid leaves.

On pulling gently at such stems they easily come away at the level of the ground because there the tissues are rotted through. (Fig. 6.) From the rotted stem tissues the bacteria may travel along the stolons to the tubers. In these, if conditions are suitable for the organism, a total rot may occur, but if conditions happen to be less suitable only stem-end infection may occur. This may not be easily visible to the naked or unobservant eye and yet it is the important factor in overwintering.

Life History

The organism overwinters in the stem-end of slightly diseased tubers where a low temperature, keeps it dormant. It is found that growth is slow at 46 deg. F. and it ceases at 39 deg. F.

The organism attacks parenchyma cells dissolving the middle lamellæ and this accounts for the typical soft rot which occurs. It does not specifically

attack vascular tissues but by rapid multiplication the bacteria plug up the xylem thus preventing the upward passage of water and accounting for the rolling of leaves, rosette top and wilting.

As to the organism causing the disease it is highly probable that more than one may give rise to similar symptons. Morse inclines to the view that in Maine it is *B. atrosepticus* van Hall. This typically attacks stems but does not cause excessive tuber rot. Harrison, from Ontario material, described *B. solanisaprus* which caused severe tuber rot in addition to black stem rot. This was the first description of such a disease in America. It has since been found in Michigan (Fig. 6) but is ascribed by Coons to *B. atrosepticus* van Hall. In the Western and irrigated parts of the United States an organism causing a similar tuber rot and stem-rot is ascribed by Shapovalov and Edson to *B. phytophthorus* Appel.

Control

Whatever the specific organism it is reasonably certain that in Canada it cannot overwinter in the soil. Hence it is to the seed tuber that one must look for control. The chief points to bear in mind are:

1. To select sound tubers for seed.
2. If it is impossible to guarantee the soundness of the seed tubers then treat with formaldehyde—2 pints in 30 gallons of water at 119 deg. F. to 122 deg. F. for two minutes. The tubers are then covered for one hour and dried. This treatment is recommended only as a good general measure since it is obviously impossible by external disinfection to affect bacteria in the tissues.

GROUP 4.

Diseases caused by Phycomycetes

The Phycomycetes are the alga-like fungi, as a rule possessing non-septate vegetative mycelium and developing both sexual and asexual spores. In some cases the mycelium is profuse and in others it is reduced to a minimum. Zoospores or motile spores are produced in the cases under consideration.

(a) Black Wart or Potato Canker

This is one of the most serious and virulent of potato diseases and is now known to occur in England, Scotland, Ireland, Scandinavia, Germany, France. Italy and it has been reported from Africa. It is common in Newfoundland but is practically confined to Pennsylvania on the continent. In Pennsylvania the report by McCubbin showed that in 1920 the disease occured in 781 gardens in 53 towns of 9 counties, so that the area involved covers approximately 3,000 acres although the actual areas total about 100 acres.

The disease is known under various descriptive names, such as Cauliflower disease, Black Scab, and Wart disease, but Potato Canker or Potato Wart are more commonly accepted. Schilberszky discovered the disease in Hungary in 1896 and attributed it to *Chrysophlyctis endobiotica*. Percival, in 1910, made

further studies and named the causal organism *Synchytrium endobioticum.* Its appearance on this side of the Atlantic was first announced by Gussow in 1909 from Newfoundland material.

Symptoms

On above-ground parts there are rarely any symptoms but occasionally the fungus may gain entrance to the haulm, lower axillary buds or leaves. If this happens the infected tissue is stimulated to excessive growth giving rise to variously shaped excrescences. It is on the tubers that the symptoms are usually found and here the buds or eyes are affected. Diseased buds are stimulated to such hypertrophic growth that they may be no longer recognisable. If the eye is affected late in the season of its growth, the nodular excrescences may be noticeable only on careful examination. But if the eyes are attacked while the tuber is quite young the excessive growth of the tissues will give rise to nodular masses entirely unlike a tuber. (See Fig. 10). The demand for food on the part of the organism will be so great that any stored in the developing tuber will be used and the tissues will collapse. In this necrotic condition lies the greatest danger. It is impossible to harvest such diseased tubers without leaving behind fragments, which are filled with sporangia, in the soil. The resting sporangia thus left behind may remain viable for several years and constitute a source of infection if potatoes of a susceptible variety are planted. Cases are on record in which the disease has reappeared after an interval of ten years in England.

Fig. 8—POTATO CANKER.—Susceptible variety (Cumberland Ideal) showing effect on tubers. Two cankers on above-ground parts can be seen. (From Supplement 18 to Jour. Bd. Agric. Eng. 1919.)

Life History of the Fungus

The resting sporangia which average about 52 microns in diameter contain many round zoospores which

measure 2½ microns in average diameter. In the spring the resting sporangia may germinate and the released zoospores are motile in the soil water for a time. Eventually they become amoeboid by the withdrawal of the single cilium and in this stage they enter the young tissues of stolon or buds. After the infected tissues have been depleted of food the fungus in each cell rounds up, develops a protective wall and becomes a summer-resting sporangium. This may germinate, the resulting zoospores giving rise to secondary infections. Toward the close of the growing season winter-resting sporangia are formed in a similar manner. Another type of summer sporangium is that in which thin-walled structures, sometimes in groups, are developed in a sorus. Each thin-walled sporangium contains numerous zoospores which are smaller than those from the ordinary type of resting sporangium.

Other Hosts

To date the tomato is the only other host known to be susceptible in America. In England *Solanum nigrum* and *S. dulcamara* are slightly susceptible.

Varietal Susceptibility

The work of Weiss and Orton shows that Green Mountain, Cobbler and Burbank are immune while Rural New Yorker, Early Ohio, Early Rose, Triumph, Pearl and Up-to-Date types are susceptible.

Control

This disease does not, so far as in known, occur in Canada and samples of any doubtful tubers should be sent immediately to a reputable authority for determination. Where the disease does occur the only control is the planting of immune varieties.

(b) Leak of Potatoes

With the development of distant markets storage and transit diseases are of increasing economic importance. "Leak" is one of the most serious of these diseases. It has been ascertained by Link that "Leak" is practically co-extensive with the potato crop of the United States. So far as the writer knows, it has not been reported from Canadian markets.

Symptoms

The disease is first apparent as a small brown discoloration around a wound such as might be caused during digging. The causal organism lives in soil and can enter the tuber only through wounds exposing the inner tissues. The fungus grows through the tissues causing the tuber to become brown over the entire

surface. In this condition it is soft, easily crushed and pressure causes the exudation of a brownish watery liquid. In advanced stages the symptoms might frequently be mistaken for those of tuber rots caused by Fusarium species.

Life History of the Fungus

Orton has shown that a similar rot may be produced by *Rhizopus nigricans* Ehrenb but the work of Link demonstrates that "Leak" is usually caused by *Pythium debaryanum* Hesse.

This fungus is aggressively parasitic if humidity and temperature conditions are satisfactory and is the common cause of "damping off" in green houses and nurseries. The mycelium is cœnocytic, except with age, irregularly branched and rather coarse. Conidia are produced terminally on branches of the mycelium or they may be intercalary. They are globose to elliptic and average 22 microns in diameter. They may germinate at once by one or more germ tubes. Oospores are also produced which are smooth, spherical and thick-walled and able to live over an adverse period. Growth is slow at 48 deg. F. and practically ceases at 41 deg. F. while it is best at about 86 deg. F. In an experimental inoculation Link found that at 86 deg. F. the fungus penetrated to a depth of 4 cm. (1½ ins.) in 67 hours.

Varietal Susceptibility

Rurals and Burbanks dug during warm weather are especially susceptible and inoculation experiments by Link tend to show that Triumph, Green Mountain, Early Ohio, Rural New Yorker and Irish Cobbler are susceptible.

Control

The disease can be controlled by care in harvesting and handling potatoes and by sorting out wounded tubers.

(c) Late Blight and Rot

This disease, caused by *Phytophthora infestans* (Mont.) De Bary, is too well known to need emphasizing as to its economic importance. It is not often that a fungus can materially affect the policy of a country but this is what *Phytophthora infestans* did in Great Britain. Late blight was so serious in 1845 in England and Ireland that the potato crop was a failure. So much was this the case in Ireland that a famine occurred and many thousands of Irishmen left Ireland for America. To relieve the distress the Corn Laws were repealed and in a sense this initiated a Free Trade policy.

The disease is now controllable so that epiphytotics are rare; nevertheless a warm, wet summer is a season of worry to the potato grower in the Maritime Provinces, Quebec, New England States and New York. It is common in Europe from east to west where the growing season is moist and mild.

Symptoms

Irregular spots at the margins or tips of leaves are produced which are at first water-soaked. The position of the lesions is due to the drainage of the water on the leaf surface in which the spores germinate. If the weather becomes dry the lesions turn brownish and dry out more or less. Under humid conditions the mycelium in the leaf tissues grows rapidly and sends out through stomata in the lower surface branches which abstrict conidia in profusion. The conidiophores are usually so numerous under these conditions that a distinct pale violet tinge is given to the affected lower surface. If the disease is not checked the leaves are rapidly destroyed and gradually the stems are affected.

On the tubers the first symptom is a slight darkening of the skin over an infected area. Later this area becomes slightly sunken and a dull reddish-brown in color. Gradually the mycelium of the fungus penetrates the tissues, causing a dry-rot if no secondary organisms are present.

A general symptom in a seriously affected area is the odor, which is difficult to describe but is something like stale herring-brine.

Life History of the Fungus

Most Phycomycetes live over adverse seasons as a sexual structure known as an oospore. It was therefore natural to look for oospores in *Phytophthora infestans* but not until 1875 was any statement made that oospores had been found. De Bary had studied the disease previously and concluded that the fungus lived over in the tuber. In 1875 Worthington G. Smith announced that he had found oospores of the fungus. De Bary again studied the case and again concluded that mycelium lived over in the tuber. Since then, L. R. Jones (1909), Clinton (1911) and Pethybridge and Murphy (1913) have found oospores in pure cultures of the fungus. The work of Melhus (1915) shows that mycelium living-over in the tuber can initiate an outbreak of the disease and that oospores have not yet been shown to give rise to the first outbreak.

Regarding, therefore, mycelium in the tuber as the over-wintering stage infection of a shoot just beginning to grow can take place by the growth of mycelium from a nearby lesion in the tuber. If the shoot is attacked early in its growth, dwarfing will result so that, when normal shoots are 8 inches tall, the infected shoots may be only just above ground. Sheltered by the foliage of healthy stems and given satisfactory temperature and moisture conditions, conidiophores will grow out through stomata in the dwarfed shoot and conidia

will be abstricted. Not many are needed to initiate the outbreak. A conidium germinates in a short time in a thin layer of water on the leaf giving rise to 8 zoospores. These are motile for perhaps an hour, then they come to rest, germinate by a germ tube and infect the leaf. Under moist summer conditions this is repeated approximately in 10 days, but the period elapsing between successive sporulations increases with decreasing humidity.

Tuber Infection

Some spores are washed through interstices of the soil to the tubers in the upper part of the hill, and if the skin of the potato is still immature, infection may easily occur. Early infection may cause total rotting of the tuber, while later infection may only give rise to small lesions. It is most important to remember that late attacks of blight will mean a plentiful supply of conidia on surface soil and plant parts at digging time and most tuber infection occurs at this stage.

Control Measures

1. Selection of sound seed tubers.
2. Thorough spraying with Bordeaux from July to mid-September.
3. Hilling of potatoes to protect upper potatoes in hills from tuber infection.
4. Removal of tops two weeks before harvesting to prevent tuber infection.

GROUP 5

Disease Caused by an Ascomycete—Wilt and Stem-Rot or Stalk Disease

Sclerotial diseases of the potato have been reported from many countries within recent years. That known as "stalk disease" caused by *Sclerotinia Sclerotiorum* is common in the West of Ireland and in the northern damper parts of England and Scotland. Growers believe that it is the most serious potato disease in these districts next to Late Blight. A similar disease caused by the same fungus attacks tomato, artichoke, sunflower, bean, squash, cucumber, carrot and turnips (Cotton, A.D.) in Great Britain. Bisby has reported a sclerotial disease of sunflower from Manitoba which is common also in Quebec and elsewhere. Mac-Alpine found a sclerotial disease of potato in Australia, which he attributed to *S. sclerotiorum*, Carpenter one in Hawaii caused by *S. Rolfsii*, and Pole Evans reports one from South Africa. During the summer of 1921 Mr. O. W. Lachaine found 10 per cent infection of a 4 acre field of potatoes in Restigouche County, New Brunswick, and four other fields of 3 or 4 acres had from 1 per cent to 2 per cent infection. The photograph (Fig.

11) is from Lachaine's material. Happily the disease according to present indications does not appear to be serious on potatoes in this country although more work must be done on it to determine this authoritatively.

Symptoms

The first signs of the disease are patches of whitish mycelium on the outside of the potato stem at, or just above, ground level. If the weather is humid profuse mycelial growth occurs with the later development of external sclerotia. At first these are whitish, turning black and finally falling to the ground. At the same time the mycelium gradually penetrates the inner tissues reaching to the pith. In the pith rapid growth takes place with the formation of internal sclerotia. These are well shown in Fig. 11. If moist conditions prevail, the stem will by this time have wilted and in many cases have fallen over, collapsing at the affected part. On the other hand dry weather will tend to check external development and only internal sclerotia may be found. The outer cortical tissues will be killed and discoloration will be prominent on the stem but it will not fall over. Nor may wilting occur but in all cases there will be a yellowing of the leaves.

Lachaine informs me that the symptoms were first noticed in New Brunswick on August 24th, 1921, at a point about half an inch above ground on the stems. A blackish zone extended from this point upward for 3 to 5 inches giving somewhat the appearance of "black-leg." By rubbing, the cortical tissues were easily removed and on September 16th (3 weeks later) the outer necrotic tissues were dried out while the leaves were yellowed. Above and below the necrotic area the stem tissues were still green. On splitting open the affected stems abundant sclerotia were found in the place of the pith.

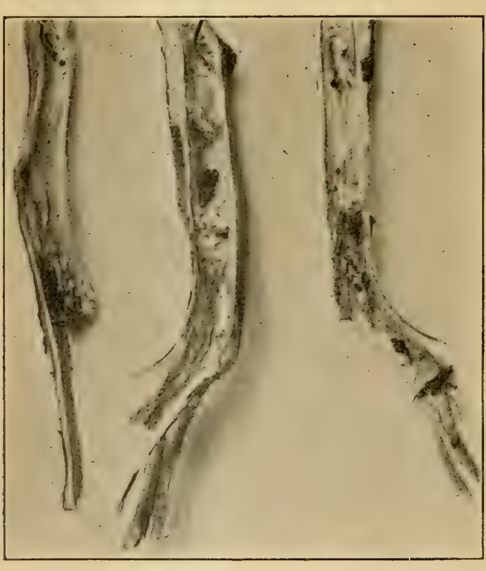

Fig. 9—Sclerotial disease of potato. Stems opened to expose sclerotia. Cortical tissues disintegrated.

Life History of the Organism

Sclerotia remain dormant in the soil until early summer when they may germinate, giving rise to apothecia bearing ascospores. The ascopores are discharged and infect the older leaves of the stem in the lowest axils.

The sclerotia may also live over winter in the soil and germinate by mycelium which can infect the plants.

In England and Ireland the organism is known as *Sclerotinia sclerotiorum*, but for the sclerotinia found by Lachaine in New Brunswick, no definite name can yet be given, although it appears to be *S. libertiana*.

Control

The only satisfactory means of control are crop rotation so that susceptible plants are not available to the fungus and careful removal and destruction of diseased plant parts.

In England, Cotton finds that late planting has proved successful since fewer old leaves are available at the time of spore discharge.

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GROUP 6

Disease Caused by a Basidiomycete.—Dry Stem-Rot and Black Scurf

This disease is known under a variety of common names of which the chief are:—dry stem-rot, black scurf, black scab, russet scab, Rhizoctonia disease, little potato, aerial potato, rosette, black speck scab and collar fungus.

The first description of Rhizoctonia was given by Duhamel in 1728 as causing a disease of saffron in France. De Candolle in 1815 gave the fungus the name *Rhizoctonia* when he discovered a similar disease on lucern. In 1851 the Tulasne brothers classified all the then known rhizoctonias as *R. violacea* but Kuhn in 1858 described a species on potato which he named *R. solani*. Webber (1890) first reported the fungus in America and in 1901 Duggar and Stewart (Bull. 186, N.Y.) gave a list of hosts attacked by Rhizoctonia. It is now known to occur generally in the United States and Canada and is reported from the West Indies, India, Australia and South America. The perfect stage was found by Rolfs in 1903 on potato stems and described as *Corticium vagum B. & C. var solani* by Burt.

Other Hosts

The complete list of other hosts would be too long to include here but mention may be made of tomato, bean, lettuce, carrot, cabbage, pea, pumpkin, beet, carnation and pansy.

Symptoms

These vary considerably with climatic conditions, age of the plant at infection, and the soil type. The sclerotial stage is very common on tubers where many black sclerotia of varying shape and size (but usually small) are found on the surface. They do not cause any apparent injury since they are superficial.

Frequently, however, the skin is more or less cracked and russetted and a still more advanced stage may give rise to scabbing. In this condition drying out in storage or the entry of secondary organisms is facilitated.

Fig. 10—Dry stem-rot of potato. Note that lesions occur about at ground level and that the plant may branch out again from below. (After Bull. 85, Mich.)

If the soil is wet or poorly drained and the temperature high, severe infection may completely cut off the young shoots before they appear above ground and this in some measure accounts for misses in the field. Sometimes side branches may grow up from below the lesion on dead haulms (Fig. 12) but such branches are weak and spindling, with yellowish leaves. Older plants severely attacked just below ground wilt and die off rapidly. Slight attacks will produce lesions on the stem tending to girdle it and in this case the tops are more or less dwarfed and yellowed. As the fungus gradually encircles the stem and penetrates the tissues, water supply is cut off increasingly so that there is a shortening of upper internodes and dwarfing of leaves which gives rise to "rosette top". At the same time the leaves may be slightly wilted and yellowish to reddish green in color and curled. This curling is easily distinguished from the crisp condition in true Leafroll.

When the stem is attacked at the time of early tuber formation so that ample food is being elaborated, the girdling of the stem cuts off the translocation of food to the stolons. This disturbance in direction of translocation causes the development of aerial tubers in the axils of leaves. I found many such cases in France during the war and in all cases where aerial tubers were formed there was a closely matted weft of mycelial growth around the stem for about two and a half inches above ground level. That the formation of aerial tubers is not due to root injury, but changed translocation of elaborated food, can be

shown by cutting away carefully the developing stolons around the base of the stem when aerial tubers begin to develop.

On the other hand, if root infection occurs the metabolism of the plant as a whole is affected, the plant is definitely dwarfed and the leaves cannot function to a normal extent so that the potato tubers formed, if any, are small, giving the condition known as "little potato".

Life History of the Organism

Usually the mycelium does not give rise to the sporiferous stage but late in the season forms the small compact blackish sclerotia on the surface of the tubers, If the sporiferous stage is developed it occurs on the weft of mycelium around the base of the stem just above ground. Here the spores are borne on basidia, four spores, measuring 6-8 by 9-14 microns, each on a short sterigma for each basidium. They germinate and cause new infections in the field. The mycelium can grow through or over the soil and in one case north of Arras, France, the writer found that the mycelium grew, during two months of a cool, moist summer, ten yards along a row from the originally infected potato. Cultivation between the rows prevented its lateral spread.

Control

Since *Rhizoctonia* prefers heavy, moist soils, drainage and the avoidance of heavy soils difficult to drain is important. If the soil is heavily infected it is inadvisable to plant potatoes. With ordinary soils seed tuber disinfection should be practised. In this connection Howitt at Guelph is doing some interesting work on control by corrosive sublimate. His work for 1920 shows that treating tubers with sclerotia on them for 2 hours in corrosive sublimate, 1 in 500 gave perfect control, while treatment for 2 hours in a solution 1 in 1,000 reduced disfigured tubers to 14 per cent. The experiments are still in progress.

GROUP 7

Diseases caused by Fungi Imperfecti (Adelomycetes or Deuteromycetes)

(a) **Early Blight**

This disease is common in years when Late Blight is not serious and while it does not attack the tubers the yield is reduced because of leaf injury. The amount of injury depends upon the season and it is greatest when hot spells alternate with moist weather. In such cases losses in yield may reach as high as 25 per cent, unless spraying is consistently practised. The disease is caused by a fungus known as *Alternaria solani* (E. & M.) J. and G.

Symptoms

During the season the leaves are the only parts attacked. The first sign of the disease is a small yellowish spot with a slightly watersoaked margin. The spot enlarges until it is from 1-8 to 1-4 of an inch in diameter and variations in the growth rate of the fungus give rise to concentric markings in the spots. The whole becomes dried out and brownish-black and it frequently happens that the central part of the lesion falls out giving rise to a modified "shot-hole" effect. When the disease is severe owing to suitable infection conditions several spots may coalesce. Under these circumstances the foliage is considerably reduced and at times very few mature leaflets will have any chlorophyll-bearing tissue with which to function in manufacturing food for plant growth and tuber development. Persistence of these conditions will involve the premature death of the vines.

The stems are not affected until late in the season and it is in debris from vines and leaves that the fungus overwinters.

Life History

The fungus may overwinter as mycelium in old lesions in plant debris or as spores but there is no known perfect stage. Under moist conditions, spores which have overwintered or have developed from over-wintered mycelium, infect leaves causing the characteristic spots. On these dead spots the fungus produces many conidiophores bearing racquet-shaped, multicellular spores. These, when washed or blown to other leaflets, germinate rapidly if moisture be present and so the disease is spread throughout the season.

Other Hosts

Alternaria solani may also attack the tomato.

Control

The only method of control is consistent spraying with Bordeaux as for Late Blight.

(b) Wilt or Fusariose

Luckily this disease, caused by *Fusarium oxysporum* Schlect, is not of serious economic importance here since the causal organism is best suited to sandy loam and a hot growing season. It is common in Pennsylvania, Ohio, Michigan, Indiana, South Dakota, etc., and it is sometimes severe in southeastern New York. The fungus is to be found in our sandy-loam soils and potatoes are attacked but wilting to any marked extent does not often occur.

Symptoms

In early stages of the disease the plant shows rolled, slightly yellowed foliage. The rolling can be differentiated from that in "Leafroll" because the leaves are not stiff and inclined to brittleness as in the latter disease. If the attack is slight rolling and yellowing of the leaves combined with a dwarfing of the plant may be the only symptoms until late in the season, when such plants die down prematurely. If the invading organism develops more rapidly the lowest leaves yellow and fall and there is a tendency to "rosette-top" quite similar to that in the Rhizoctonia disease. Given optimum conditions for the fungus the vines lose their lower leaves and wilt. In very severe cases a lesion may be obvious just below ground level but, as a rule, it is only on cutting through the stem that one can see the browned condition of the vascular tissues. Some times only one or two haulms in a hill are affected but generally the whole plant shows the symptoms.

An inspection of the root system proves that root tips and feeding roots are rotted off and larger roots when sectioned are seen to have browned vascular tissues. Lesions occur on the stolons owing to attacks from the outside. The organism can grow from the affected stem or stolon into the vascular tissues of the tuber and here it gives rise to "net-necrosis". The necrosis of the vascular tissues of the tubers varies from slight, when it only penetrates a quarter of an inch from the stem, to severe when it may extend from the stem-end over half way through the tuber. In the latter case tuber rot may occur if moisture and temperature conditions during storage are suitable. In the former such tubers used for seed develop "spindling" sprouts.

Sources of Infection

There are two sources of infection:—(1) the soil and (2) diseased seed-tubers. In the first case wilting does not usually occur until late in the season if it occurs at all, and this is the condition generally here. In the second case, either the plants are so spindling that they cannot grow or wilting may occur earlier in the season when tubers are about half grown.

Resistant varieties

Little is yet known of varieties actually resistant but it is important to notice that early potatoes escape the disease. Thus Irish Cobbler tubers are fairly mature by the time Fusariose becomes prevalent while Green Mountain tubers are just forming.

Control

1. If the soil is known to be infested crop rotation must be practised and if the infestation is severe a long rotation of five or more years is necessary.
2. Tubers should be selected for soundness. All germinated tubers show-

ing a tendency to "spindling sprout" should be discarded. If the tubers have not been sprouted the stem-end of suspicious tubers can be clipped and those with net-necrosis discarded, or the stem-end half only discarded if the bud end is healthy.

3. Plant disease-escaping varieties, i,e. early types.

(c) Common Scab

In Europe, Africa, Australasia, and North America common scab occurs probably everywhere the potato is grown. The disease is caused by a fungus closely related to the higher bacteria and known as *Actinomyces scabies* (Thax.) Gussow. It is often present to such an extent as to prohibit potato culture but usually the chief loss comes from depreciation in the sale value of the tubers. Estimates show that there is a variation from 5 p. c. to 75 pc. of the crop which is unfit for sale.

Symptoms

This is a tuber disease and the symptoms vary from shallow, rough pittings if the attack occurred when the tubers were nearly mature, to deep rough pittings with furrows and cracks if the potatoes were infected when young. At first the scab appears as a minute red-brown spot. It gradually extends outward, becomes irregularly corky and deeper brown in color. Scab mites, white grub and wire worms enlarge and deepen the injury, making the tubers still less valuable.

Life History of the Organism

The fungus lives overwinter in the scab spots on the tubers or in the soil. In the soil it may persist for many years and in that case long rotation is not sufficient but soil treatment must be considered. Alkaline soils favour the fungus and acid soils check it. Thus the addition of lime, stable manure, potash or ashes to soil is dangerous when it is known that the scab organism is present.

Other Hosts

Turnips, beets and mangels are susceptible to attack by this organism and therefore these crops cannot be used in a rotation.

Varietal Susceptibility

Irish Cobbler, Sir Walter Raleigh and Carmen among others are fairly resistant to scab.

Control

Two essentials are clean seed tubers and clean soil. If the soil is clean great care should be taken regarding the seed tubers and when there is any doubt, disinfection should be thoroughly performed. Even in the case of infected soil,

it is essential that clean seed tubers be used since otherwise the infestation is being increased. Long continued investigations are demonstrating the value of sulphur as a medium for soil treatment. Martin in 1921 found that only 8.9 p.c. of clean tubers developed in infested, untreated soil but when 600 lbs. per acre of finely ground sulphur were applied there were 33.5 p.c. clean tubers and when 600 lbs of inoculated sulphur were used per acre the clean tubers reached 50.9 per cent. This, it is to be remembered, is in soil severely infested with *Actimomyces scabies.* In some soils 600 lbs. of sulphur per acre might be disadvantageous while 300 lbs. would be satisfactory. By inoculated sulphur is meant sulphur having mixed with it soil containing sulphur oxidising bacteria.

(d) **Skin spot** (*Oospora pustulans*)

Reference has already been made to the fact that skin-spot has been shown by Shapovalov to be a stage of Powdery scab.

(e) **Silver scurf**

Harz in 1871 first described this disease when it occurred in Austria and since then it has been found in Germany, Great Britain, Ireland and North America. It is caused by a fungus named *Spondylocladium atrovirens* Harz.

Symptoms

In its early stages silver scurf, under moist conditions, causes olive black patches to appear on the surface of the potato. These dingy patches are the conidiophores and spores of the fungus. The spots may be small, or may cover an area half an inch or more in diameter. Later in the season the surface layers are slightly raised by the abundant growth of mycelium in the cells below and at this time small, black, superficial sclerotia are formed. When washed the raised areas appear whitish or silvery, giving rise to the name "Silver scurf". Still later in the season these raised areas gradually become depressed owing to the death and collapse of infected cells. If the season is moist enough for rapid fungus growth the areas increase in extent until in severe infections the whole surface of the tuber is involved and the fungus penetrates more deeply into the tissues. As a result it is not unusual to find tubers which are entirely discolored and shrunken. Surface layers with sclerotia slough off and thus infect the soil.

Life History

The fungus overwinters as sclerotia which are very minute. These may be on the surface of the potato or in the cells of the outer layers or in debris sloughed off into the soil. How long such sclerotia may live in a dormant condition is doubtful, but given moist, warm environment they germinate readily by conidiophores. Vegetative development is rapid and from spore to spore occupies a period of only four or five days under optimum conditions. The conidiophores are erect, dark-brown, and tall (120 microns) and the spores are borne in whorls on the upper parts of the conidiophores. The spores are dark

brown, five to seven celled and apparently quite resistant to adverse conditions. It is thus possible that spores developed later in the season may over winter.

Control

The ordinary methods of seed-tuber disinfection do not control this disease and the only suggestion at present efficacious is that of tuber selection.

(f) Dry Rot of Tubers

Heavy losses in stored potatoes sometimes occur in those years when Late Blight does not appear to be an important factor. Such losses are mainly due to tuber rots caused by species of *Fusarium*. It is difficult accurately to ascertain the extent of such losses but they take a heavy annual toll from growers and dealers.

Symptoms

Fig. 11—Original photograph from material collected at Macdonald College, September 21st, 1921. The minute sclerotia on the inside and outside of the affected stems are shown.

The rot usually starts from a wound which penetrates the tissues or which may be merely an abrasion of the skin. At first the affected tissues are firm and cheesy and the fungus produces white or pink tufts of mycelium, conidiophores and conidia on the surface. As the diseased part increases in area and depth the tissues dry out, shrivel and eventually become quite hard. Under warm, humid conditions the rot develops more rapidly and is softer, at first, but finally the tuber becomes shrunken and hard. If *Fusarium* species only are present there is no foul odour but usually bacteria are to be found associated and hence the rot may be softer and malodorous.

Causal organisms

Fusarium discolor sulphureum is probably the chief cause of dry rot but *F. oxysporum* may penetrate so far into the tuber tissues that it also gives rise to storage rot. Other species of *Fusarium* occasionally cause similar rots but they are not usually so serious.

Relation to Late Blight Rot

The rot caused by *Phytophthora infestans* when severe is seen at digging time and the heaviest losses begin to show soon thereafter in storage but *Fusarium* rots inflict heaviest losses in the later storage period. It is obvious, however, that small lesions caused by *P. infestans* are eminently suitable as points of entrance for *Fusaria* and infection by *Fusaria* commonly occurs. The rot is then not "dry" as in the case of infection by *Fusarium* alone.

A feature of importance is the amount of rot in storage which occurs in certain years even after consistent spraying with Bordeaux is practised. Murphy (Ottawa Bull. 44) has mentioned this and I have had many request for information from Quebec farmers. During a warm wet autumn the sprayed plants remain green and continue to grow well on to harvest. At digging time, the tops are still green and under such conditions some Late Blight is almost sure to be present. Spores fall on moist tubers and infection may occur which does not manifest itself until later in storage. Even if no Late Blight be present, the tubers are immature so far as their skins are concerned and therefore are easily injured. Through these injuries *Fusaria* enter and in the spring there is the likelihood of heavy loss from dry rot. It would probably be better to cut the tops some seven to ten days before digging to remedy this, and experiments are under way to determine the efficacy and economy of such a procedure.

Storage Conditions

Moist warm storage is suitable for the rapid spread of dry rot (and other storage rots) and it is therefore important to be able to ventilate well and to maintain a temperature about 35° F., or slightly lower so long as the freezing point is not reached.

Fusaria can live over the summer on refuse in the corners and on the walls of bins, and clean bins are essential to safety.

Effect on plants

If infected tubers are used for planting the rot may continue so that no plant develops or the shoots are weak and spindling. It is entirely inadvisable to use even doubtful seed.

Control

1. Avoid injury to tubers as much as possible.
2. Use cleaned and disinfected bins.
3. Keep the storage places cool (35° F.), well-ventilated, and dry.
4. Avoid digging tubers for storage with immature skins.
5. Plant healthy seed tubers.

(f) Net-necrosis

The term "net-necrosis" was first used by Orton in 1914 to describe a discoloration of the vascular tissues of the tubers. The color varies from brownish to black and it may appear in the stem-end only or extend throughout the tuber. There are now three accepted types of net-necrosis, viz:—*Frost net-necrosis, Fusarium net-necrosis* and *Leafroll net necrosis.* It is also suggested that a net-necrosis may be caused by adverse soil or growing conditions.

In any of these cases it is inadvisable to use such tubers for seed purposes since they will develop spindling plants.

The net-necrosis under consideration is that which is the result of Fusarium infection, usually *F. oxysporum.*

Symptoms

The discoloration of the vascular tissues varies from a slight browning at the extreme stem-end to an intense darkening two-thirds or more through the tuber. In very severe cases the discoloration may extend to the bud-end but usually the distal half of the tuber is free from any symptoms. There are all gradations between these extremes. Slices cut across the stem-end show that not only the vascular elements of the ring but also the secondary vascular strands in the cortex and medulla are affected.

On cutting successive slices it is seen that the discoloration becomes less intense as the bud-end is approached and that it is more confined to the vascular ring and cortex and later to the ring only. Gradually the discoloration disappears and slight water-soaking in the vascular ring is the last symptom towards the bud-end. By paring the tuber down to the vascular ring the net work of discolored tissues is easily seen, Externally, affected tubers appear to be sound, but occasionally, the blackened bundles at the stem-end may show thro ıgh the skin.

Effect on Plants

Fig.12 --Photograph of half Petri dish showing sclerotia developed in artificial culture on dextrose agar.

Such tubers used for seed purposes give rise to spindling plants, the weakening of the plant depending on the extent of vascular necrosis. The basal buds are most affected and the apical buds least.

Control

1. Plant only healthy seed. If in doubt slice off the stem-end and discard tubers showing strong discoloration.

2. Sprout tubers before planting and discard those with weakly sprouts, or if apical sprouts are strong while basal sprouts are spindling cut off and discard the stem-end.

3. It is probable that dusting the cut surface with finely ground sulphur would be helpful.

(h) **Black dot disease**

Ducomet in France, in 1908, reported the occurrence for the first time of a disease which he called "dartrose" caused by *Vermicularia varians*. McAlpine some two years later found it in Victoria, Australia, and Doidge more recently in South Africa. McAlpine named it "Black dot disease", an excellent descriptive name.

In the late summer and autumn of 1921 I discovered what appears to be the same disease at Macdonald College in Quebec. This is the first time its appearance is noted on this continent and a full description will be given later elsewhere.

Symptoms

The first symptom is a slight yellowing of the foliage which begins at the tips of leaflets and gradually involves the whole leaves. It may or may not be accompanied by dwarfing of the plant depending upon the earliness and severity of the infection. The yellowing will show early in the season on plants heavily infected but usually it is a midsummer symptom. The yellowing is followed by browning and withering of the leaves and if moist conditions prevail minute black sclerotia will develop on the surface. At this time the lower stem parts are covered with sclerotia and gradually the stem darkens and becomes brittle. On opening the stem the pith is seen to be disorganized and sclerotia line the inside walls of the vascular cylinder. Figure 11 indicates the size and number of the sclerotia both on the inside and outside of the stem. Roots and rhizomes are attacked and the tubers are covered with the minute sclerotia. It apparently does not cause serious damage to the tuber since the mycelium is confined to the superficial tissues and the sclerotia are developed on the surface or are slightly erumpent.

Mycelium is to be found throughout the stem and leaf tissues of yellowed plants which have sclerotia on the leaves.

The organism

Ducomet describes the sclerotia as astomic pycnidia 75—150 microns in diameter with setæ 100 to 130 microns long and at least biseptate. The spores are slightly curved and 18-22 microns by 2.5 to 3 microns. In my cultures the spores are slightly smaller and the setæ longer and no pycnidia have been found. McAlpine also states that he has found no pycnidia in Australia. More detailed discussion will appear elsewhere.

Figure 12 illustrates the development of sclerotia in a Petri dish culture on dextrose agar.

Other Hosts

Ducomet states that this organism is parasitic on Tomato and *Physalis peruviana*. I have artificially infected tomato but have not yet tried *Physalis sp.*

Control

This disease is serious only in that it weakens plants and therefore reduces the crop. Exactly to what extent it is of economic imortance it is as yet impossible to state.

McAlpine advocates burning the haulms of diseased plants and selecting clean tubers for planting.

GROUP 8

"Physiological" diseases

(a) Black heart

As the name indicates, the symptoms of black heart are confined usually to the medullary region. The blackened tissues are irregular in outline and almost always elongated from stem to bud and with branches extending towards the buds. Occasionally there may be large black spots scattered irregularly through the flesh of the tuber and sometimes the vascular tissues are blackened. Surface discoloration of the tuber occurs in cases of insufficient aeration but usually no surface symptoms are evident.

There are two conditions which bring about black heart. The first is overheating and this is a shipping trouble. Among potatoes shipped during the winter in stove-heated cars those in the vicinity of the stove are frequently found to be badly affected with black heart. The experiments of Bartholomew in 1913 showed that heating tubers to 100-113° F. for 14-18 hours brought about changes in the respiration rate of the tubers so that in the overheated environment more oxygen is demanded than is available. The innermost tissues are the first to be affected by the insufficient oxygenation and they become necrotic and brown to black in colour. Gradually the dead cells dry out becoming shrunken, tough and black.

The second condition was demonstrated by Stewart and Mix at the N. Y. Geneva Station. They showed that black heart occurs at low temperatures if the oxygen supply is markedly deficient. Tubers confined with a volume of air equal to the volume of potatoes required up to 40 days for black heart to develop at 40° F.

Whether affected tubers sprout or not depends upon the extent of the collapsed tissues and upon whether the injury is due to insufficient oxygenation at high or low temperatures. Usually the latter require a longer time for sprouting but if no surface injury is present and the buds sprout well there is no harm in using such tubers for seed. It is obviously unwise to use tubers with surface lesions for seed since the lesions will become breeding grounds for fungi and bacteria.

Control

It must be remembered that potatoes stored at high temperatures and for a long period require more ventilation than those stored at lower temperatures or for short periods.

1. Potatoes should not be stored more than six feet in depth at temperatuies below 45° F. for a lenghhy period of time. At temperatures of 50° F. to 70° F. they should not be piled more than 3 ft. deep if they are to be kept longer than a month.

2. Small potato pits do not need extra ventilation but the tubers should be protected from frost.

(b) **Frost necrosis**

In Canada, as in the northern tier of states of our neighbour, the main crop is in constant danger of exposure to freezing temperatures from the time of harvest to planting or to retail sale. There are two types of frost injury, viz:—that in which complete freezing occurs and that in which no superficial symptoms are noticeable. In the first case freezing is due to exposure to a very low temperature or to prolonged freezing at a somewhat higher temperature. The tubers are frozen solid and the tissues collapse on thawing. The soft, wet condition resulting is easily recognized.

The second type is due to exposure to temperatures just below the freezing point or to a very low temperature for a short time. In this case, the tuber is never frozen completely but certain tissues only are affected. Upon exposure to ordinary storage temperatures the affected tissues become necrotic and are blackish in colour after being exposed to oxidation in the air. The necrosis is of three general types, viz., net, ring, and blotch.

In "net" necrosis there is a general blackening of the finer vascular elements extending from the vascular ring into the medulla and cortex.

A more pronounced blackening in the vascular ring and adjacent tissues gives the "ring" type of frost necrosis. This is often most apparent at the stem-end.

When the necrotic areas are larger and less defined we have the "blotch" type and this is often found in the cortical tissues.

Frost injury before or during harvest may give rise to any of these types or modifications of them, but, as a rule, the ring type predominates if exposure

is short since vascular tissues are more sensitive than parenchymatous, while the blotch type is common with long exposures to chilling temperatures.

(c) Net necrosis or Vascular discoloration

In discussing Leafroll, Fusariose, and Frost necrosis it was pointed out that the term "net-necrosis" is applicable to any of these tuber troubles if the delicate vascular network is discolored.

In discussing vascular discoloration Edson in 1920 says: "A popular impression has prevailed that any except the most superficial stem-end discoloration might be taken as a trustworthy indication of the presence of Fusarium, or, at least, that the stock was grown on vines affected with Fusarium or Verticillium. Somewhat extensive preliminary observations and cultural studies, made by the writer both at the time of harvest and during or at the close of the rest period, on stock grown in sections where Fusarium blight and wilt do not occur, as well as in sections where they are known to be general, show that, while Fusarium and Verticillium undoubtedly do cause vascular discoloration of potato tubers, discoloration can not be accepted as proof of the presence of Fusarium or, indeed, of any other organism, nor can the absence of discoloration be confidently accepted as proof of the sterility of the vessels near the stolon attachment. There seems to be reason to think that vascular necrosis may often arise from purely physiological causes and that it need not necessarily be seriously abnormal, though frequently it is."

This author found that out of 3,042 planting from discolored tissues 1,352 gave no growth.

(d) Internal brown spot

In this disease brown spots are scattered through the flesh of the tuber and are not confined to the vascular ring. The spots consist of dead brown cells surrounded in many cases by cork cells. It is possibly something like stippen in apples and is associated with unfavourable soil moisture conditions at a critical period in the growth of the tuber.

(e) Spindling sprout

Weak spindling sprouts are likely to develop from tubers affected by mosaic, leafroll, fusarium necrosis, etc., and in all instances such weaklings are best eliminated from the crop. It is also found that potatoes grown under unfavourable soil or climatic conditions tend to give rise to spindling sprouts when used for seed. Similarly the same strain grown year after year will gradually lose vigour and "run out" resulting in weak progeny. It is advisable to sprout potatoes before planting and to discard those with thin, straggling, spindling sprouts.

(f) Hollow heart.

This condition occurs as a result of the too rapid growth of the tubers. Some varieties, such as the Rural New Yorker, when grown in rich soil, frequently develop hollow heart. The tissues surrounding the irregular space in the heart of the tuber are brown and lined with a corky layer. The trouble is not serious from a pathological point of view.

(g) Arsenical injury

This is not serious when ordinary precautions are observed. Arsenic oxide is the base of any arsenical spray used in controlling chewing insects and its use alone would cause severe burning to the foliage. It is therefore necessary to use it in a combined form such as Paris green, lead arsenate, calcium arsenate, etc. The arsenate is better used in combination with Bordeaux, so that sufficient lime is present to prevent burning of the foliage. Burning occurs where insects have made injuries and in the axils and margins of leaves where the insecticide is likely to be held in quantity. The use of a finer spray from high pressure nozzles will usually prevent such accumulations of material on the plant.

General considerations in control

1. Control of potato diseases by the grower involves as a first essential that the grower know the diseases which have to be controlled. Every grower of potatoes on a large scale ought to familiarize himself with symptoms and with the major points in the life history of the causal organism if such exists. To do the right thing at the correct time necessitates accurate knowledge. Information can always be obtained from Macdonald College in Quebec, from the Ontario Agricultural College in Ontario, from other agricultural colleges throughout the Dominion and also from Provincial and Dominion Departments of Agriculture. No grower need lack technical help to-day in this respect.

2. Next to a knowledge of the diseases to be controlled and how to control them, the most important point is to know thoroughly the variety or varieties most suitable for the locality and the market. It is best to grow only one or two varieties and to know these so that "off varieties" can easily be detected and rogued from the seed plot. Grow a seed plot every year and select hills for freedom from disease and for yield and type. In arranging the seed plot choose clean land, prepare it well, practise deep plowing and rotation with legumes and cultivate the potatoes thoroughly.

3. As to the seed tubers themselves the selection of thoroughly clean, sound tubers is a prime requisite. Too many growers still plant scab, black

leg, blight, etc. and expect to get potatoes. If it is impossible to obtain first class, clean seed the next best thing is to treat what is available.

4. For seed tuber treatment two chemicals are availabie :—mercury bichloride, which is a deadly poison, and formaldehyde which is also a poison, but which warns one by the gas given off.

Mercury bichloride or corrosive sublimate treatment

Soak the seed tubers in a solution made of 4 ozs. of mercury bichloride in 30 gallons of water for half an hour. If Black scurf is present treatment for a longer period is advisable acording to the work of Howitt at Guelph (see p. 91). The addition of one ounce of mercury bichloride to the 30 gallons of water after each sack has been treated will keep the solution up to strength. If larger quantities are to be treated vats should be used so that the tubers can be handled in crates. It is important to remember that with corrosive sublimate (mercury bichloride) no metal vessel can be used. Treated tubers are poisonous to stock and man. The corrosive sublimate can first be dissolved in 2 gallons of hot water and added to 28 gallons of cold, since it is not easily soluble in cold water.

Formaldehyde treatment

1. Soak seed tubers for 15 minutes in a solution of formaldehyde made by adding 1 pint (or 1 lb.) of concentrated formaldehyde (commercial of 40%) to 30 gallons of water.

2. A method recently tested by Melhus is recommended if the grower can arrange a tank in which formaldehyde solution of double the above strength is heated to 118° to 122° F. In this case the tubers are soaked for two minutes at this temperature and then covered for an hour before cutting.

5. If it is not convenient to plant immediately after the completion of seed tuber treatment, care must be taken that the treated tubers are not placed in sacks or containers which have not been disinfected.

6. When cutting the tubers discard all rotted stock and also those tubers showing browning or blackening in the vascular ring at the stem end. It may happen that the discarded tuber would give a healthy plant but the chances are against it and "safety first" is a wise saw.

7. During the growing season give the plants good cultivation.

8. Spray thoroughly with Bordeaux mixture from the time the plants are eight inches high. Make the applications about every two weeks depending upon the weather. If the weather is moist and warm and plants are developing new leaves very rapidly they must be covered with spray and hence spraying may have to be done every ten days and perhaps later during a drier

spell at longer intervals like 2½ weeks. Spray before a wet spell and use a fine spray which will cover *both* sides of the leaves. Dusting is as good as spraying for potatoes in most localities. To control potato-chewing insects it is necessary to add calcium arsenate or lead arsenate to the spray or dust. It is not necessary here to deal with the preparation of Bordeaux mixture or dust, but any grower desiring information will be gladly accommodated if he will write to Macdonald College.

9. Finally greater care must be taken in digging, handling and storing potatoes. It is unfortunate that an excellent yield is sometimes spoiled in its last stages by bad handling.

SCLEROTIAL DISEASE OF THE POTATO

By O. W. Lachaine, B.S.A.

Sclerotial diseases of the potato have been reported from many countries within recent years. That known as "stalk disease" caused by *Sclerotinia sclerotiorum* is common in the West of Ireland and in the northern damper parts of England and Scotland. Growers believe that it is the most serious potato disease in these districts next to "Late Blight". A similar disease caused by the same fungus attacks tomato, artichoke, bean, cucumber, carrot, turnip, corn, pea, cabbage, cauliflower, hemp and chicory (Cotton, A. D.) in England. Bisby has reported a sclerotial disease of sunflower from Manitoba which is common also in Quebec and elsewhere. MacAlpine found a sclerotia disease of potato in Australia, which he attributed to *S. sclerotiorum;* Carpenter one in Hawaii caused by *S. Rolfsii*, and Pole Evans reports one from South Africa. During the summer of 1921 the writer found 10 per cent infection of a 4 acre field of potatoes in Restigouche County, New Brunswick, and four other fields of 3 or 4 acres had from 1 per cent to 2 per cent infection.

Symptoms

The first symptom noticed by the writer, August 24, 1921, was a blackish zone extending from the surface of the soil to about 5 inches in height giving it somewhat the appearance of "blackleg". By rubbing, the cortical tissues were easily removed. Three weeks later, on September 16th, the outer necrotic tissues were dried out while the leaves were yellowed. Above and below the necrotic area the stem tissues were still green. On splitting open

the affected stems abundant sclerotia were found in the place of the pith. These are well shown in Fig. 1-A.

These symptoms are not the first, while conducting experiments in the green house, with potato and tomato plants, I have discovered their precedents.

The first signs of the disease are patches of whitish mycelium on the outside of the potato or tomato stem at the point of infection at the surface of the soil, where the natural infection ordinarily takes place. If the weather is humid profuse mycelial growth occurs with the later development of external sclerotia. At first these are whitish, turning black and finally falling to the ground. At the same time the mycelium gradually penetrates the inner tissues reaching to the pith. In the pith rapid growth takes place with the formation of internal sclerotia.

Fig. 1.—Sclerotia in pith of potato stem.

Cultural Characteristics

The sclerotia, after being frozen for a month, sterilized in 1:1000 solution of mercuric chloride and washed in sterile water, develop profuse mycelium but in no case was an apothecium observed.

The mycelium develops more rapidly on sterile carrot than on potato or oat-meal agar. The carrots were first covered with a white mass of mycelium, which gradually turns brown and then black, forming a solid mass of sclerotia on the surface, shown in Fig. 2.

On oat meal and potato agar the rapidity and the mode of growth of the mycelium are the same. The mycelium ordinarily grows on the surface of the agar, but in few exception it is slightly upright. In every case there is a large number of small sclerotia (Fig. 3 and 4) although on the carrot the sclerotia are large.

Inoculation

Potato plants and one of tomato were inoculated on the stem a little above the surface of the soil with mycelium obtained by growing sclerotia, from the interior of a potato stem, on a piece of sterile carrot.

Fig. 2.—Sclerotial disease of potato. Solid sclerotial growth on surface of carrot.

The infection on the tomato stem was more rapid than that on the potato stems. On the tomato the mycelium grew and the cortical tissues were destroyed 2 inches above soil level and the plant wilted. Fig. 5. (A indicates upper limit of cortical tissue destroyed.)

At present one of the inoculated potato stems has tissues for $^3/_4$ of an inch in height and half of the circumference of the stem destroyed, on another,

Fig. 3—Small sclerotia on potato agar.

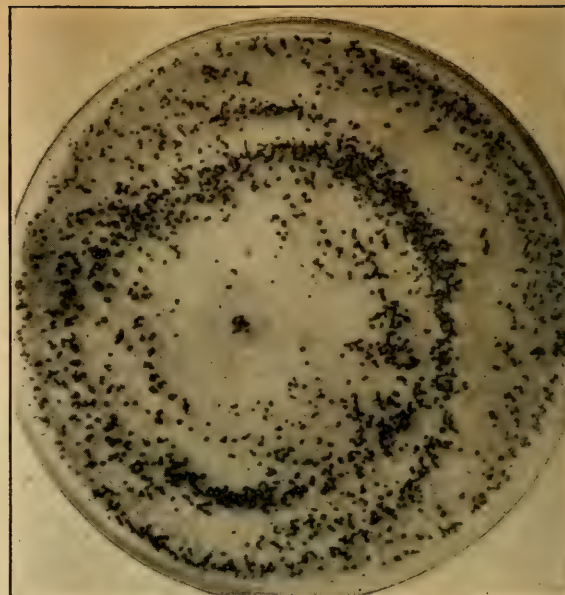

Fig. 4.—Small sclerotia on potato agar.

Fig. 5.—Tomato inoculated at soil level. Note disintegrated cortex up to A.

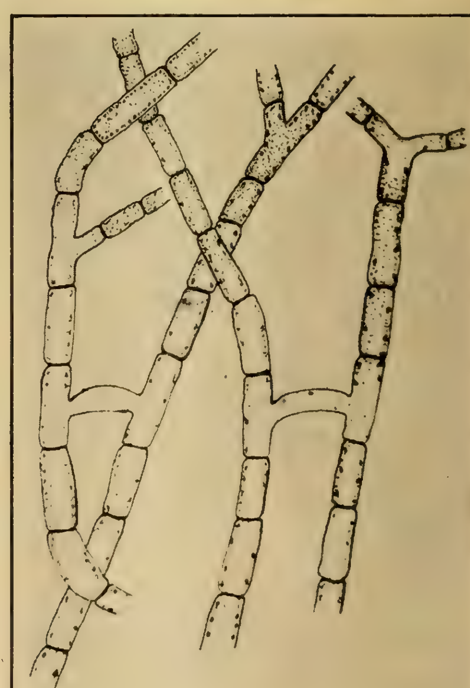

Fig. 6.—Camera lucida drawing of the mycelium

superficial mycelium was abundant at the place of inoculation and has penetrated the tissues which it was covering but has not spread any farther.

Sclerotia remain dormant in the soil until early summer when it is possible they may germinate giving rise to apothecia bearing ascospores. So far no apothecia has been observed by the writer in the development of the sclerotia.

The sclerotia may also live over winter in the soil and germinate by mycelium which can infect the plants, which has been shown above.

No definite name can yet be given to the fungus which causes this potato disease in New Brunswick, but on the results so far obtained and on the microscopical examination of the mycelium, it is identical with that of (*Sclerotinia libertiana Fckl.*) This is shown in Fig. 6. All tend to show that the fungus is *S. libertiana*.

Control

The only satisfactory means of control are crop rotation so that susceptible plants are not available to the fungus and careful removal and destruction of diseased plant parts.

ABSTRACTS OF CANADIAN PLANT PATHOLOGICAL LITERATURE

By A. W. McCallum, Division of Botany, C. E. F., Ottawa

The abstracts and references given herewith include the papers on plant pathology published in Canada during 1921. In addition, an attempt has been made to include those papers which have been omitted from previous lists. It is felt that the three bibliographies which have now been published contain a fairly complete list of all papers on plants pathology which have been published in Canada.

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ANONYMOUS.—*Ann. Rept. of Supt. of Spraying for Ont.*—Ont. Dept. Agric. 1-16. 1898.

ANONYMOUS.—*Discussion on decay in timber.*—Trans. Can. Soc. Civ. Eng. 29 (part 1): 324-365. 20 fig. 1915.—This discussion by a number of engineers deals with conditions, forms and results of attacks on various kinds of structural timber by fungi, more particularly by *Merulius lachrymans, Coniophora cerebella, Trametes serialis* and other unidentified forms.

ANONYMOUS.—*White Pine Blister Rust.*—Ann. Rept. Min. Lands, Forests and Mines, Ont. 1916: 147-149. 1 pl. 1917.—Presents the life history of the rust together with an account of its distribution in Ontario.

ANONYMOUS.—*Canadian Branch of the American Phytopathological Society.* Sci. Agric. 1: 18. 1921.—An account of the second annual meeting of the Canadian Branch.

BEDFORD, S. A.—*Preventives of Smut in Wheat.* Central Exp. Farms Rept. 324-325. 1905.

BETHUNE, C. J. S.—*Orchard Diseases.* 35th Ann. Rept. Ont. Agric. Coll. and Exp. Farm for 1909: 34-36. 1910.

BISBY, G. R.—*Stem Rot of Sunflowers in Manitoba.* Sci. Agri. 2: 58-61. Fig. 1-3. 1921.—An undetermined species of *Sclerotinia*, causing a stem rot of the cultivated sunflower, appeared in Manitoba during 1920 and 1921. Symptoms are rotting of the stem, usually at the surface of the ground, and wilting of the plant. The fungus lives over winter in the soil and spreads rather rapidly.

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Caesar, L.—*The most important diseases of currants and gooseberries.* Ont. Dept. Agric. Fruit Br. Bull. 222: 31-33. Fig. 17-19. 1914.

Caesar, L.—*Apple Scab (Venturia pomi).* Fruit Growers Assoc. Ont. 45: 54-69. 3 figs. 1914.

Caesar, L.—*Black knot of plums and cherries.* Can. Hort. 42: 281-282. 1 fig. 1919.

Cowan, P. R.—*Some Potato Problems.* 8th Ann. Rept. Que. Soc. Prot. Plants for 1914-1915: 116-120. 1915.

Cunningham, G. C.—*The White Pine Blister Rust.* Crown Lands Detp. N.B. Ann. Rept. 57: 103-106. Pl. 1-4. 1917.—Blister rust has not been found in New Brunswick yet though no systematic survey has been made for it.

Dickson, B. T.—*Plant Diseases of 1920-21.* 13th Ann. Rept. Que. Soc. Prot. Plants for 1920-21: 66-67. 1921.

Dickson, B. T.—*Report of the Delegate to the Canadian Branch of the American Phytopathological Society.* 13th Ann. Rept. Que. Soc. Prot. Plants for 1920-21: 20-23. 1921.—Presents abstracts of the papers given at the second annual meeting.

Dickson, B. T.—*Diseases of the Potato.* Sci. Agric. 2: 55-57. Fig. 1-2. 1921.—The first of a series of papers upon potato diseases in which tipburn is described and the potato leaf hopper credited with causing this disease.

Dickson, B. T.—*Diseases of the Potato.* Soi. Agric. 2: 93-96. Fig. 3-5. 1921.—An account of the symptoms, effects and control of mosaic and leaf roll.

Dickson, B. T.—*Diseases (sic) of the Potato.* Sci. Agric. 2: 163-167. Fig. 6-9. 1922.—A description of the symptoms and control of powdery scab together with an account of the life history of the causal organism. Black leg is treated similarly.

Duff, J. S.—*White pine blister rust.* Ann. Rept. Min. Agric. Ont. for 1915: 22-1916.—This disease is present in Brant, Durham, Halton, Kent, Lincoln, Wellington and Wentworth Counties.

Eastham, J. W. and J. E. Howitt.—*Fungus diseases of vegetables.* Ont. Dept. Agric. Bull. 171: 37-62. 11 fig. 1909.

Eastham, J. W.—*Annual Report of Plant Pathologist.* 11th Ann. Rept. B. C. Dept. Agric. for 1916: 58-62. 1917.

Eastham, J. W.—*Annual Report of Provincial Plant Pathologist.* 12th Ann. Rept. B. C. Dept. Agric. for 1917: 51-56. 1918.

Eastham, J. W.—*Apple scab and its control.* Can. Hort. 41: 253-254. 1 fig. 1918.

Eastham, J. W.—*Report of the Provincial Plant Pathologist.* 13th Ann. Rept. B. C. Dept. Agric. for 1918: 32-36. 1 pl. 1919.

Eastham, J. W.—*Report of the Provincial Plant Patologist. Vancouver.* 15th Ann. Rept. B. C. Dept. Agric. for 1920: 51-55. 1 pl. 1921.

Faull, J. H.—*Fomes officinalis (Vill.), A Timber Destroying Fungus.* Trans. Royal Can. Inst. 11: 185-209. Pl. 18-25. 1 fig. 1916.—Presents the results of a study of this interesting fungus which has been known and used medicinally since the time of Dioscorides. The active principle is a resinous substance, agaricin, which, with other resins, may form as much as 70% of the dry weight of the fruiting body. It has been believed by certain European mycologists

that this form and *Polyporus sulphureus* were closely related. This view, however, is shown to be erroneous. The gross and histological features of the decay produced by this fungus, together with an account of its distribution and hosts, are also described.

FAULL, J. H.—*Preliminary Report: In Report of the Forestry Branch, 1918.* Ann. Rept. Min. of Lands ,Forests and Mines, Ont. for 1917-1918: 156-160. 1919.—An introductory note on needle blight of white pine, a disease which is characterized by the progressive reddening of the new leaves as they unfold from the buds until from one to two thirds of the total length at maturity are involved. Several hundred diseased trees were marked for further study.

FAULL, J. H.—*Report for 1919.* Ann. Rept. Min. Lands, Forests and Mines, Ont. for 1918-1919: 119-125. 1920.—Observations made on coniferous trees at a distance of four to six miles from winter roasting beds indicate that no injury occurs in winter from sulphur fumes. Analysis of the results obtained from a study of marked trees indicated that blighted young white pines usually recover while a variable percentage of older trees also recover but more slowly. The mortality in old trees is about 5%. In an endeavour to determine the cause of needle blight several hundred inoculations, using juice from diseased foliage, were made on healthy twigs of healthy trees. No infection resulted, however. The root systems of several small, blighted trees were next examined. This revealed the seat of the trouble. The main branches of these root systems were in most cases killed back from 4-12 inches or more from the tips and few of the laterals appeared very healthy. In contrast the root systems of young, healthy trees were normal. The leaf injury, then, is due to the fact that, in early summer, when there is a sudden increase in the water requirements of the tree the roots are unable to supply it. The cause of the root injury is, as yet, unknown though drought seems the most likely explanation. A list of tree diseases observed in Northern Ontario is appended.

FAULL, J. H.—*Forest Pathology In Report of The Forestry Branch, 1920.* Ann. Rept. Min. Lands and Forests, Ont. for 1919-1920: 224-235. 9 fig. 1921.—Continuing the study of white pine needle blight, observations on marked trees indicate that affected trees up to six in diameter are likely to recover but the death rate in older trees is much higher with recovery more uncertain and slower. Temperature records show that frost is not a factor in the occurrence of blight. Winter browning of the foliage of coniferous trees was very prevalent in 1920. In some cases trees were killed outright and in other twigs and small branches as well as foliage suffered. This injury is usually localized, occurring on the south side of the tree and in the lower portion of the crown. It is due to transpiration occurring when the ground is frozen and the roots are unable to replace the water given off by the leaves. "Red branch" of balsam is ascribed to insect wounding of the bark late in the season followed by winter frosts. A twig blight of balsam and canker of poplar are also mentioned together with a preliminary note on heart rots of coniferous trees.

FLETCHER, J.—*Smuts in small grain.* Central Exp. Farms Rept. 141-142. 1 fig. 122-124. 3 fig. 1895.

FRASER, W. P.—*Notes of Some Plant Diseases of 1913.* 6th Ann. Rept. Que. Soc. Prot. Plants for 1913-1914: 45-50. 3 fig. 1914.

FRASER, W. P.—*Storage Rots of Potatoes and Other Vegetables.* 6th Ann. Rept. Que. Soc. Prot. Plants for 1913-1914: 50-51. 1914.

FRASER, W. P.—*The Cereal Rusts.* 7th Ann. Rept. Que. Soc. Prot. Plants for 1914-1915: 116-120. 1915.

FRASER, W. P.—*Plant Disease Investigations in Western Canada.* Agric. Gaz. Can. 8: 318-320. 1921.—Systematic work in plant pathology was begun in Western Canada in 1917, when an agreement was reached whereby the Dominion Government appointed and paid the investigators while the universities and agricultural colleges provided laboratory and greenhouse facilities. Most of the work to date has been in connection with stem rust of wheat although smut of western rye grass and stripe disease of barley have also been investigated. Eight strains of stem rust have been separated and plant breeding for rust resistance is being carried on at the University of Saskatchewan. This is the line of research which is most promising of results in combatting the rust.

FRENCN, P. E.—*Experimental work.* B. C. Dept. Agric. Ann. Rept. 12: 24-28. 1917.

Gorham, R. P.—*Powdery scab of the potato.* Dept. Agric. N. B. Hort. Div. Leaflet 3: 1-6. 3 fig. 1914.

Harrison, F. C.—*Fungous Diseases.* 21st Ann. Rept. Ont. Agric. Coll. and Exp. Farm for 1895: 187-188. 2 fig. 1896.

Harrison, F. C.—*Report of the Bacteriologist.* 23rd Ann. Rept. Ont. Agric. Coll. and Exp. Farm for 1897: 121-128. 2 fig. 1898.

Hearst, W. H.—*Experimental Work.* Rept. Min. Agric. Ont. 60-62. 1917.—Several extracts from the report of the Vegetable Specialist.

Henry, G. S.—*Experimental Work.* Rept. Min. Agric. Ont. 1918.—Several notes of interest appear in this report. These are: Potato Investigational work, 19-20, Winter Injury to Fruit Trees, 20-21, and Potato Demonstrations, 72-78.

Hockey, J. F.—*Germination of Teliospores of Puccinia Antirrhini.* 13th Ann. Rept. Que. Soc. Prot. Plants for 1920-1921: 54-57. 1 fig. 1921. —An account of a successful attempt to germinate the teleutospores of the snapdragon rust. Germination is apparently favoured by exposure to low temperatures.

Howitt, J. E.—*Fungus Diseases.* 38th Ann. Rept. Ont. Agric. Coll. and Exp. Farm from for 1912: 29-31. 1913.—Some ginseng diseases mentioned.

Howitt, J. E.—*Raspberry yellows and cane blight.* Can. Hort. 36: 237-238. 1913.

Howitt, J. E. and L. Caesar.—*The more important fruit tree diseases of Ontario.* Ont. Dept. Agric. Bull. 257: 1-44. Fig. 1-31. 1917.—A publication for fruit growers. It is aimed to enable them to recognize and treat the serious fruit tree diseases which occur in Ontario. These are all described and control measures given for each. A spray calendar is appended.

Howitt, J. E.—*Experiments in the Control of Rhizoctonia or Black Scurf of Potatoes.* Sci. Agric. 1: 256. 1921. —The results of experiments during two years in the control of rhizoctonia indicate that corrosive sublimate of strength 1 in 500 for two hours gives perfect control.

Hay, B.—*Experimental Work.* 12th Ann. Rept. B. C. Dept. Agric. for 1917. 29-30. 1918 .

Hutchings. C. B.—*The Black Knot of Plum and Cherry.* 8th Ann. Rept. Que. Soc. Prot. Plants for 1915-1916: 85-88. 1 fig. 1916.

Jones, D. H.—*Fire Blight and Alfalfa Leaf Spot.* 36th Ann. Rept. Ont. Agric. Coll. and Exp. Farm for 1910: 163-168. 1 pl. 2 fig. 1911.

Jones, D. H.—*Tomato blight.* Ont. Veg. Growers' Assoc. Ann. Rept. 11:60-67. 2 fig. 1915.

Kynoch, W. and R. J. Blair.—*Is Wood a Suitable Material for the Construction of Mill Buildings?* Contract Record. Aug. 7: 622. 1918. Construction. Aug. 249. 1918. Canada Lumberman and Woodworker. Oct. 15; 31. 1918. Canadian Engineer. Aug. 1: 95. 1918.

Kynoch, W. and J. A. Coderre.—*Creosote Treatment of Jack Pine and Eastern Hemlock for Cross-ties.* Canada, Dept. of Interior, Forestry Branch Bull. 67: 1-24. Pl. 1-8. Fig. 1-2. 1919.

Létourneau, F.—*Fire Blight.* 8th Ann. Rept. Que. Soc. Prot. Plants for 1915-1916: 42-45 . 1916.

Lochhead, W.—*The Story of Spraying Mixtures.* 13th Ann. Rept. Que. Soc. Prot. Plants for 1920-1921: 12-19. 1921.—The presidential address before the thirteenth annual meeting.

Macoun, W. T.—*Winter injury to fruit trees in Canada 1917-18.* Ann. Rept. Pomol. and Fruit Growing Soc. Que. 31-34. 1918.

Maheux, Georges.—*Some Methods of Seed Treatment.*—13th Ann. Rept. Que. Soc.Prot. Plants for 1920-1921: 47-50. 1921.

McCallum, A. W.—*Abstracts of Canadian Plant Pathological Literature.* Sci. Agric. 1: 78-80. 1921.—Abstracts of papers on plant pathology published in Canada during 1919 and 1920.

McCready, S. B.—*Fungi and Plant Pathology.* 36th Ann. Rept. Ont. Agric. Coll. and Exp. Farm for 1910: 37-47. 6 fig. 1911.

McCubbin, W. A.—*White pine blister rust on currants.* Can. Hort. 40: 34. 1 fig. 1917.

McRostie, G. P.—*The Immunization of Plants.* Sci. Agric. 1: 122-124. 1921.—Advocates the production of resistant varieties as the logical means of combatting plant diseases.

Middleton, M. S.—*Plant diseases.* 12th Ann. Rept. B. C. Dept. Agric. for 1917: 20-21. 1918.

Mitchell, W. G.—*Treated Wood Block Paving.* Canada, Dept. of Interior, Forestry Branch Bull. 49: 1-40. 20 fig. 1915.

Mitchell, W. G.—*The Preservative Treatment of Timber.* Canada Lumberman and Woodworker. June 15: 34. 1916.

Murphy, P. A.—*The black leg disease of potatoes caused by Bacillus solanisaprus.* Dom. Exp. Farms Bot. Circ. 11: 1-8. Fig. 1-6. 1916.—A brief description of the symptoms and injuries due to black leg together with the life history and control of the causal organism.

Murphy, P. A.—*Late blight and rot of potatoes caused by the fungus Phytophthora infestans.* Dom. Exp. Farms Bot. Circ. 10: 1-13. Fig. 1-2. 1916.—Life history of the fungus with symptoms and control of the disease caused by it.

Murphy, P. A.—*Potato Spraying in Prince Edward Island.* Ann. Rept. Dept. Agric. P. E. I. 98-103. 1 pl. 1917.

Murphy, P. A.—*Some constitutional diseases of the potato.* Can. Hort. 42: 9. 1919.

Murphy, P. A.—*Investigation of Potato Diseases.* Canada, Dept. of Agric. Dom. Exp. Farms Bull. 44 (2nd series.) 1-86. Fig. 1-34. 1921.—This bulletin embodies the results of the author's extensive investigations on potato diseases. The following diseases are treated very fully—late blight, black leg, leaf roll, mosaic, curly dwarf and related troubles. A comprehensive bibliography is appended.

Newton, Margaret A.—*A Preliminary Report on the Occurrence of Biologic Forms of Wheat Stem Rust in Western Canada.* Sci. Agric. 1: 213. 1921.—Until 1916 only one biologic form of stem rust was known to occur on wheat. To date eleven strains have been isolated in Canada. Among these there are no new forms, all of them having been described by Stakman. Breeding resistant varieties seems to be the most promising method of controlling rust but before this can be done effectively more must be known of the number, characteristics and distribution of the biologic forms in Canada.

Panton, J. H.—*Plant Diseases.* 20th Ann. Rept. Ont. Agric. Coll. and Exp. Farm for 1894: 7, 8, 13, 17, 18. 9 fig. 1895.

Panton, J. H.—*Instructions for spraying.* Rept. Dept. Agric. N. B. 209-222. 13 fig. 1897.

Petch, C. E.—*Spraying vs Dusting.* Sci. Agric. 1: 171-172. 1921.—The writer has found dusting to be as efficient as spraying in the control of apple scab and biting insects though not in the control of sucking insects. It is more easily applied and is as cheap.

Robertson, R.—*Experiments to prevent smut in oats and barley.* Dom. Exp. Farms Rept. 283-285. 1900.

Roy, J. A.—*Methods of Prolonging the Durability of Fence Posts.* 13th Ann. Rept. Que. Soc. Prot. Plants for 1920-1921: 57-65. 1921.—Describes a number of different treatments and gives the approximate cost of each.

Sanders, G. E. and A. Kelsall.—*Dusts and Dusting for Insect and Fungus Control. Part I. The Present Status of Dusting.* Sci. Agric. 1: 14-18. 1921.—A discussion of the relative merits

of dusting and spraying reaching the conclusion that as far as the orchard is concerned the former is on the whole more satisfactory.

SANDERS, G. E. and A. KELSALL.—*Dusts and Dusting for Insect and Fungus Control. II. Dusts containing Copper and Arsenic.* Sci. Agric. 2: 7-14. 1921.—A consideration of the properties of copper-arsenic dust which was first used in 1917. The writers conclude that this or some other similar dust will be an important factor in controlling plant pests.

SANDERS, G. E. and A. KELSALL.—*Spraying vs Dusting.* Agric. Gaz. Can. 8: 134-136. 1921.

SAUNDERS, W.—*Spraying for rust.* Dom. Exp. Farms Rept. 33. 1893.

SHARPE, T. A.—*Bordeaux mixture for potato rot.* Dom. Exp. Farms Rept. 336. 1893.

SHUTT, F. T.—*Chemistry of the copper and salt fungicides.* Dom. Exp. Farms Rept. 171-175 1894.

TICE, C.—*Seed Potato Certification in British Columbia.* Agric. Gaz. Can. 8: 448-450. 1921.

WINSLOW, R. M.—*Apple scab control in British Columbia.* Can. Hort. 40: 56-58. 1 fig. 1917.

WHETZEL, H. H.—*The Present Status of Plant Pathology in Agriculture.* 13th Ann. Rept Que. Soc. Prot. Plants for 1920-1921: 24-30. 1921.—An address given before this society.

ZAVITZ, C. A.—*Treatment of Smut.* 23rd Ann. Rept. Ont. Agric. Coll. and Exp. Farm for 1897: 170. 1898.

ZAVITZ, C. A.—*Cereal and Potato Diseases.* 31st Ann. Rept. Ont. Agric. Coll. and Exp. Farm for 1905: 182-185, 199-201. 1906.

ZAVITZ, C. A.—*Treatment of Grain for Smut.* 33rd Ann. Rept. Ont. Agric. Coll. and Exp. Farm for 1907: 179-181. 1908.

ZAVITZ, C. A.—*Treatment of Grain for Smut.* 34th Ann. Rept. Ont. Agric. Coll. and Exp. Farm for 1908: 183-185. 1909.

ZAVITZ, E. J.—*Tree Diseases.* Ann. Rept. Minister Lands, Forests and Mines, Ont. for 1916-1917: 155-158. 1918.—Gives the distribution of the blister rust in Ontario together with measures to be adopted respecting it.

ZAVITZ, E. J.—*Tree Diseases.* Ann. Rept. Min. Lands, Forests and Mines, Ont. for 1917-1918: 155-156. 1919.—Reports the eradication of *Ribes* from the Provincial Forest Station in Norfolk County. Four men worked for four months to do this work on an area of about 100 acres. This indicates the difficulty of such control measures on large areas of land.

CONTENTS

FIFTEENTH ANNUAL REPORT

OF THE

Quebec Society for the Protection of Plants

1922-1923

Supplement to the report of the Minister of Agriculture

PRINTED BY ORDER OF THE LEGISLATURE

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FIFTEENTH ANNUAL REPORT

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Quebec Society for the Protection of Plants

1922-1923

To the Honourable J. E. Caron,

Minister of Agriculture

Quebec.

Sir:—

I have the honour to present herewith the fifteenth Annual Report of the Quebec Society for the Protection of Plants, containing the proceedings of the meetings of the Society, which were held at Macdonald College, Ste. Anne de Bellevue, Que., on December 7 and 8th, 1922, and March 15th, 1923.

Included are the papers that were read, and the reports of the officers of the Society.

I have the honour to be,

Sir,

Your obedient servant,

B. T. DICKSON,

Secretary-Treasurer.

Macdonald College, Quebec.

QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS

OFFICERS FOR 1922-1923

President—Professor W. Lochhead, Macdonald College.

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G. Maheux, Esq., Provincial Entomologist, Quebec.
G. Chagnon, Esq., Montreal.
Prof. G. Bouchard, Ste. Anne de la Pocatière.

Auditor—Dr. E. Melville DuPorte, Macdonald College.

Delegate to the Royal Society of Canada—Prof. W. Lochhead, Macdonald College.

Delegates to the Ontario Entomological Society—Prof. Lochhead and Rev. Fr. Leopold.

Delegates to the Canadian Branch of the American Phytopathological Society, Dr. B. T. Dickson and Prof. G. R. Cosette.

LIST OF MEMBERS 1922-23

Armstrong, Tom	Macdonald College
Adams, John	C. E. F., Dept. of Agr., Ottawa.
Baillairgé, V	Forest Service, Quebec.
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Chagnon, G	P. O. Box 521, Montreal.
Charron, Dr. A. T	St. Hyacinthe, Que.
Clayson, G. H	17 Charron St., Montreal.
Cloutier, H	La Trappe, Que..
Coderre, J. A	Forest Products Laboratory, Montreal.
Corcoran, J. A., M. D	8, 36th Avenue, Lachine, Que.
Cossette, Prof. G. R	La Trappe, Que.
Cummings, R. F	330 First Avenue, Maisonneuve.
Davis, M. B	C. E. F., Dept. of Agriculture, Ottawa.
Davis, M. W	777 Shuter St., Montreal.
Dickson, Dr. B. T	Macdonald College.
Dion, J. A	Quebec.
Doig, J	Ste. Anne de Bellevue.
Drayton, F. L	C. E. F., Dept. of Agriculture, Ottawa.
Dunlop, G. C	422 Mackay St., Montreal.
DuPorte, Dr. E. M	Macdonald College.
Dustan, A	Wolfville, N. S.
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Flewelling, D. B	Fredericton, N. B.
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Fraser, Prof. W. P	Saskatoon, Sask.
Giroux, T	Forestry Service, Quebec.
Gooderham, C. B	C. E. F., Dept. of Agriculture, Ottawa.
Gorham, A. C	Fredericton, N. B.
Gosselin, Alfred	Ste. Anne de la Pocatière.
Gosselin, Charles	Fort Coulonge, Que.
Gousie, Rev. Prof	St. Mary's College, Montreal.
Gregoire, M. L	Forest Service, Quebec.
Guenette, L	Forest Service, Quebec.
Gussow, H. T	C. E. F., Dept. of Agriculture, Ottawa.
Hale, J. D	Forest Products Laboratory, Montreal.
Hall, G. H	672 Durocher St., Montreal.
Hall, Landon	Cowansville, Que.
Hammond, G. H	Macdonald College.
Hetherington, S. J	Dept. of Agriculture, Edmonton, Alberta.
Hockey, J. F	Lab. of Plant Pathology, St. Catharines, Ont.
Honoré, Rev. Father	La Trappe, Que.
Howitt, M. H	Macdonald College.
Hutchings, C. B	Entomological Branch, Dept. of Agric., Ottawa.
Gordon, W. L	Macdonald College.
Jack, Norman E	Chateauguay Basin, Que.
Jackson, F. Slater, M. D	108 Park Ave., Montreal.
Jenkins, M. H	Ottawa, Ont.
Keating, Rev. Prof	Loyola College, Montreal.

Kieffer, H. F.	Forest Service, Quebec.
Lachaine, O. W.	Macdonald College.
Lavoie, J. H.	Horticultural Bureau, Quebec.
Leopold, Rev. Father	La Trappe, Que.
Levasseur, Rev. Paul	Ste. Anne de la Pocatière.
Lloyd, Prof. F. E.	McGill University, Montreal.
Lochhead, Prof. W.	Macdonald College.
Lods, E. A.	Macdonald College.
Macaulay, R. R.	Ste. Anne de Bellevue.
MacCallum, A. W.	C. E. F., Dept. of Agriculture, Ottawa.
MacClement, Dr. W. T.	Queen's University, Kingston, Ont.
Maheux, G.	Provincial Entomologist, Quebec.
Major, T. G.	Tobacco Division, Dept. of Agriculture, Ottawa.
McLennan, A. H.	Ontario Agriculture College, Guelph, Ont.
McMahon, E. A.	John Cowan Chemical Co., Montreal.
McOuat, J. E.	Macdonald College.
McRostie, Dr. G. P.	C. E. F., Ottawa.
Menard, J. H.	Forestry School, Berthierville.
Milne, A. R.	D. S. C. R., Ste. Catharines, Ont.
Moore, G. A.	159 Querbes Ave., Outremont.
Nagant, H.	64 Maple Ave., Quebec.
Newton, Miss Dorothy	Manitoba Univ. Winnipeg.
Nolet, Louis	College de Lévis, Lévis, Que.
Pasquet, Jos.	Ste. Anne de la Pocatière.
Perry, Miss M.	Macdonald College.
Petch, C. E.	Hemmingford, Que.
Petraz, Mr.	Horticultural Service, Quebec.
Piché, G. C.	Chief Forester, Quebec.
Reid, Peter	Chàteauguay Basin, Que.
Raymond, L. C.	Macdonald College.
Raynaud, Mr.	Berthierville, Que.
Richardson, J. K.	Macdonald College.
Roy, H. B.	Sudbury, Ont.
Saunders, L. G.	Cambridge University, Cambridge, Eng.
Savoie, F. N.	Dept. of Agriculture, Quebec.
Simard, J.	Dept. of Agriculture, Quebec.
Simmons, P. M.	Lab. of Plant Pat., Saskatoon, Sask.
Smith, R. H.	Macdonald College.
Southee, G. A.	356 Durocher St., Outremont.
Spittall, J. R.	Annapolis, N. S.
Stanford, Miss P. Clayton	Dartmouth, N. S.
Stevenson, J. N.	Gardenvale, Que.
Stewart, K.	Macdonald College.
Stohr, Rev. L. M.	Ironside, Que.
Strickland, E. H.	Edmonton, Alberta.
Summerby, Prof. R.	Macdonald College.
Swaine, Dr. J. M.	Entomological Branch, Dept. of Agric., Ottawa.
Tawse, W. J.	Macdonald College.
Tessier, G.	Forest Service, Quebec.
Treherne, R. C.	Entomological Branch, Ottawa.
Victorin, Rev. Bro.	University of Montreal, Montreal.
Willey, Dr. A.	58 Metcalfe St., Montreal.
Winn, A. F.	32 Springfield Ave., Westmount.

HONORARY MEMBERS

James W. Robertson, Esq., LL.D., C.M.G., Ottawa.
Hon. J. E. Caron, M.P.P., Minister of Agriculture, Quebec.
F. C. Harrison, D.Sc., Macdonald College.
Rev. Father Superior, Dom Pacome Gaboury, La Trappe, Que.
Auguste Dupuis, Village des Aulnaies.
Canon V. A. Huard, D.Sc., Quebec.
Rev. Father Superior, Ste. Anne de la Pocatière.
J. C. Chapais, D.Sc., St. Denis-en-bas, Que.
A. Gibson, Esq., Dominion Entomologist, Ottawa.
Hon. Minister of Crown Lands and Forests, Quebec.

FINANCIAL STATEMENT

Receipts.

Brought forward	135.80	
Provincial Government Grant	250.00	
Interest on deposit	5.19	
	———	$ 390.99

Disbursements.

Lecturers	$ 74.22	
Delegate to Ontario Entom. Soc	20.00	
Delegate to Royal Society	15.00	
Secretary	50.00	
Postage and Typewriting	25.43	
General Expenses of meeting	14.10	
Printing	8.51	
Balance on hand April 14th, 1923	183.73	
	———	390.99

Auditor:
E. MELVILLE DUPORTE.

W. LOCHHEAD,
President.

B. T. DICKSON,
Secretary-Treasurer

NOTES: Since the Canadian Phytopath. meeting was held at Macdonald College, there were no delegates expenses therefor.

Only one delegate was able to attend the Ont. Entom. Soc.

REPORT OF THE MEETINGS.

Summer Meeting.

The Summer Meeting was postponed and held on December 7 and 8th, in conjunction with the Annual Meeting of the Canadian Branch of the American Phytopathological Society, which met at Macdonald College. The joint meetings were well attended among those present being Dr. F. C. Harrison, Prof. Wm. Lochhead, Prof. W. P. Fraser, Dr. B. T. Dickson, Dr. R. E. Stone, Dr. J. H. Faull, Prof. F. E. Lloyd, Dr. M. T. Cook, Dr. E. M. Duporte, Dr. W. T. MacClement, Prof. Georges Maheux, Prof. T. G. Bunting, Prof. R. Summerby, Dr. A. MacTaggart, Dr. E. G. Hood, Mr. C. Petch, Miss D. Newton, Mr. Omer Caron, Mr. W. Tawse, Mr. J. G. Coulson, Mr. L. C. Raymond, Mr. F. L. Drayton, Mr. G. C. Cunningham, Mr. J. F. Hockey, Mr. McCurry, Mr. T. G. Major, Mr. R. J. Blair, Mr. J. D. Hale, Mr. Coderre, Mr. Vanterpool, Mr. Atwell, Mr. Baker, Mr. Armstrong, Mr. Spittall, Mr. Gibson.

On the evening of December 7th, a combined meeting of the Quebec Society for the Protection of Plants, Quebec Pomological Society and the Canadian Branch of the American Phytopathological Society was held with Prof. Wm Lochhead in the chair. At this meeting, about a hundred were present and enjoyed addresses from Dr. Melville T. Cook, of the State University of New Jersey, the guest of our Society, and Mr. G. E. McIntosh, the Dominion Fruit Commissioner.

At the business meeting of the Canadian Branch, the following officers were elected:

President, Prof. W. P. Fraser.
Vice Pres., Dr B. T. Dickson.
Sec.-Treas., Dr R. E. Stone.
Councillors, Dr. W. T. MacClement.
Mr. G. C. Cunningham.

The program is given below.

PROGRAMME

THURSDAY DEC. 7th.

Morning session.

10-12 Registration and accommodation.

After-noon Session.

2 P. M. Address. Prof. W. Lochhead (Pres. Q. S. P. P.).

La campagne contre les sauterelles dans Québec en 1922.............................G. Maheux.
Plant diseases of western Quebec in 1922.........B. T. Dickson.
The natural control of the Green Apple Bug by a new species of Empusa....................A. G. Dustan.

Control of the Onion maggot in 1922............W. J. Tawse.
The Dominion Entomological Service...........A. Gibson.
Désinfection et parcelles......................O. Caron.
The pollination of certain vegetable plants by insects..................................Mr. Treherne.
Wood v. Fungi (Demonstration slides).........R. J. Blair and J. D. Hale.

Evening session.

7.30 P. M. Welcome. Principal F. C. Harrison.

Address by Dominion Fruit Commissioner.......G. E. McIntosh.
The Past and Future of Plant Pathology.........Dr. Melville T. Cook, State Univ. of New Jersey.

Informal meeting.

Morning session.

Friday Dec. 8th.

9 A. M. Business meeting.

Resolutions, appointments of committees and officers.
Report on the plant disease survey.............F. L. Drayton.
Cultural characteristics of certain root-rot FusariaT. G. Major.
The present statuts of the White Pine Blister Rust în Canada.............................A. W. McCallum.

Afternoon session.

2 P. M.

Red Branch of Conifers.......................J. H. Faull.
Two plant diseases new to Ontario...............J. E. Howitt.
Control of Oat Smut...........................B. T. Dickson, R. Summerby and J. G. Coulson.
Five years' experiments in the control of Oat SmutJ. E. Howitt and R. E. Stone
Control of Raspberry mosaic...................J. F. Hockey.
Balsam rusts...................................H. P. Bell and J. H. Faull.
Peony diseases.................................J. G. Coulson.
Pea root-rot and wilt of Canning peas...........R. E. Stone.
Distribution of Ribes and Cronartium ribicola in Ontario............................. G. H. Duff.
Soft rot of Iris.................................J. K. Richardson.
Blue-stem of the Black raspberry...............J. F. Hockey.
Plant pathology in public schools...............W. A. McCubbin.
Smut control experiments with copper carbonate dust and other substances.................W. P. Fraser and P. M. Simmonds.
Stem rust (P. Graminis) on grasses in western Canada...................................W. P. Fraser.

ANNUAL MEETING.

The fifteenth annual meeting of the Quebec Society was held in the Biology Building of Macdonald College, on March 15th, 1923. In view of the fact that the Society had already had a meeting in December, the session occupied only the afternoon. There was a good turn out of members with Prof. L. Caesar of the Ontario Agricultural College, Mr. G. E. Sanders, of the Deloro Chemical Company, and Mr. A. Gibson, the Dominion Entomologist, as the chief speakers.

The business meeting opened at 2 p. m.
The minutes of the last meeting were approved.
The report of the treasurer was read and accepted.
The following were the officers appointed for the following year:—

President:—Prof. W. Lochhead, Macdonald College.
Vice-Président:—Rev. Fr. Leopold, La Trappe.
Secretary-treasurer:—Dr. B. T. Dickson, Macdonald College.
Directors:—C. E. Petch, Esq., Hemmingford, Que.
Prof, G. R. Cossette, La Trappe.
A. F. Winn, Esq., Montreal.
Prof. Bro. Victorin, Univ. of Montreal.
G. Maheux, Esq., Provincial Enthomologist, Que.
G. Chagnon, Esq., Montreal.
G. Bouchard, M. P., Ste-Anne-de-la-Pocatière.
Dr. A. T. Charron, St-Hyacinthe.
Auditor:—Dr. E. Melville Duporte, Macdonald College.
Delegate to the Royal Society of Canada:—Prof. W. Lochhead.
Delegates to the Ontario Entomological Society:—Prof. W. Lochhead, Rev. Fr. Leopold and Dr. E. M. Duporte.
Delegates to the Canadian Branch of the American Phytopathological Society:—Dr. B. T. Dickson and Prof. Cossette, Mr. O. Caron and Mr. J. G. Coulson.

It was resolved that the Society, so far as funds are available, continue to help in aiding investigations concerning economic diseases caused by insects, fungi, or bacteria.

The place and time of a summer meeting was left to the discretion of the Executive.

The general session followed and the papers of both meetings pertaining to our Society are given in the succeeding pages.

THE PROTECTION OF PLANTS.

By Prof. W. Lochhead, Macdonald College.

In this first joint meeting of the Canadian Phytopathological society and the Quebec Society for the Protection of Plants, I may be permitted to say a few words, first, with regard to some Canadian pioneer botanists and entomologists who "blazed the trail" and made it possible for us to meet here to-day as plant-protection societies; and second, with regard to the special nature of the task of phytopathologists and economic entomologists.

Botany as a distinct department of Canadian University instruction has been late in coming into its own. This was largely due to the fact that Botany for many years was considered of importance only in so far as it related itself to medicine. Queen's University was perhaps the first to appoint a Professor of Botany, but Dr. Fowler had practically no assistance. I can recall the appointment of Prof. Penhallow to the chair of Botany in McGill University in 1883. Prior to that time the instruction in Botany was very meagre, and was done as a subsidiary enterprise by some member of a stronger Natural History Department. In the University of Toronto, Botany was linked up with Zoology, and did not function as a separate Department until some years later.

These were the days of the systematist and the morphologist. Histology had been introduced from Europe by some of the newer workers and its effect was to broaden and deepen Morphology. Physiology had not reached the status of a separate sub-division, and little or no experimentation was done. Mycology was in its infancy and the fungi as a group were given but little attention.

As might be expected, then, our pioneer botanists were systematists, but confining their attention mainly to the flowering plants. To their efforts we are indebted for the fairly complete list of Canadian plants and their distribution. Dr. John Macoun was an indefatigable collector, and his position as Botanist of the Geological Survey enabled him to travel extensively in all the provinces. His collections form the basis of the National Herbarium at Ottawa.

Another man who had an important influence on Canadian Botany was Dr. James Fletcher of Ottawa, Dominion Entomologist and Botanist. Althouh his interests were mostly with insects, yet he devoted much time to the ecological study of plants. His knowledge of plants was of a macroscopic nature, and he was practically unacquainted with the newer phases of Botany, such as histology, physiology and the culture of fungi. However, Fletcher was a fluent and popular lecturer, and wherevre he went (and he travelled widely in Canada) he left an indelible impression on the people, so that they became interested in

insects and plants. Moreover, his Annual Reports and Bulletins were widely read.

Plant Pathology is the newest of the sciences arising out of Botany. Its special field is not yet quite clear to many persons—even to many botanists. Mycology is not Plant Pathology, for the former deals with fungi, the latter with the diseases caused by fungi. The study of fungi as causative agents of disease should be carefully distinguished from the study of the diseases caused by the physiological reactions and responses of the plants to the parasites. Such pathological conditions form the field of study of the plant pathologist. To know the cause and its effect is not enough: We should know how the cause produces the effect. Then only will the treatment of plant diseases become rational and not empirical.

The plant pathologist is concerned chiefly with the diseases of plants, consequently he classifies diseases according to the relations existing between the parasite and the host. Roughly, then, he distinguishes three main types of diseases:

1. Those diseases where the parasite destroys the host and lives upon the dead or dying protoplasts, such as pear blight, many leaf spots and rots;

2. Those diseases where the parasites do not destroy the host, but continue to live symbiotically with the living cells, such as black knot, peach leaf curl, crown galls, etc.;

3. Those diseases produced by the invasion of the xylem vessels by the mycelium of the parasite, thereby cutting off the supply of nutrient solution, such as the "wilts", and many timber bracket-fungi.

It is evident that plant pathology as a science had to wait for the development of normal plant physiology and of a technique such as the bacteriologist has at his command. Moreover, a knowledge of biochemistry, systematic and morphological botany, histology and cytology is a fundamental acquirement of the plant pathologist.

Three outstanding factors contributed to the great development of our knowledge of plant diseases and methods of control:

1. The epochal investigations of European botanists on the causal organism and their relation to such plant diseases as smut (1853), the potato-rot disease (1861), and wheat rust (1865).

2. The work of American investigators in the seventies and eighties, such as Burrill, Farlow, Arthur ,Bessey, Halstead, Earle and others whose contributions added substantially to our knowledge of fungi and of fungous and bacterial diseases.

3. The work of the U. S. Department of Agriculture and of the newly established Agricultural Colleges and Experiment stations, which gave a tremendous impetus to the study of plant diseases and control measures from 1885 onward to the present.

Economic Entomology occupied a place in the public mind before Plant Pathology, because insects were studied long before fungi and the losses by insects were more obvious. They were readily recognized as causal agents of injury to plants, and were always interesting subjects for study.

While much investigation had been devoted to the structure and habits of insects, but little progress had been made in the control of injurious forms until the sixties and seventies of last century. In those decades the United States suffered serious losses from the Rocky Mountain Locust, the Potato Beetle, the Cotton Worm, and the Federal Government appointed specialists to investigate conditions. As an outcome of the reports of Riley, Thomas and Packard, strong efforts were made to devise methods of controlling these and other minor pests.

The establishment of State Agricultural Colleges and Experiment Stations about the same time gave a further stimulus to Economic Entomology, and as a result the United States have maintained the lead in this branch of science for the last fifty years.

Canada has always been in close touch with the work done in the United States, for many of the economic problems are identical. However, with her limited appropriations for the study of such problems, she has been plodding lalong in her own way, but at the same time profiting by the experience of the workers in the United States.

The economic entomologist of to-day studies the insect as the plant pathotogist does the fungus and the disease. He tries to determine all the interactions and responses between the insect and its environing factors, such as food, temperature, moisture, etc. Moreover, he studies the habits of the insect critically in all stages of its life-history—all with the object of discovering the best method of control. As both the entomologist and the plant pathologist must seek their main facts in the field where the injuries are being done, it was found necessary to establish field stations or laboratories where the investigators carry on their work. Such a departure is new, but already the results show the wisdom of it.

It is obvious, then, that the more fully the entomologist can scrutinize and analyze the various ecological factors that play upon insects, the more likely will he be able to secure important results. He should, therefore, have a fair working knowledge of botany, pathology, chemistry, geology, meteorology, physiology and agriculture, but he should confer frequently with experts in these subjects, for such conferences may often correct wrong conclusions

from his observations and even open up new and unsuspected lines of investigation.

Most of our pioneer entomologists were systematists, and as such collected a large amount of data regarding the distribution and habits of insects that have been helpful to later workers. Some of our early workers, such as Dr. W. Saunders, Dr. Brodie, and others, did much breeding work, and to them we are indebted for many valuable life-histories. To Dr. James Fletcher Canadian entomology owes a great debt for his long service of more than twenty years as Dominion Entomologist. So strong was the influence of his personality that no matter where one goes one comes across the footsteps of this great master. He laid the foundations of our Economic Entomology so firmly that the late Dr. Gordon Hewitt, his successor, was able to build a fine superstructure of which we are justly proud.

This Province of Quebec will long revere and hold in memory the name of Abbe Provancher who worked for many years almost single-handed on the insects of this province. The men of to-day are just beginning to realize the full value of the services rendered by men like Provancher, Fletcher and Saunders, of the last generation.

I cannot allow this occasion to pass without making mention of our own Society for the Protection of Plants.

This Society was founded in 1908 and has published fourteen reports. It is supported by an annual grant from the Quebec Department of Agriculture who also bears the costs of publishing the annual report. Its membership is made up of French-speaking and English-speaking persons who are interested in the protection of plants from insects and fungous diseases. At its annual meetings the Federal Entomological Branch and the Division of Botany of the Central Experimental Farm have invariably assisted by sending some of their members to give addresses. For such services the Society is extremely grateful.

Perhaps I do not over-emphasize the importance of this small Society when I say that through its reports it, more than any other provincial agency, has brought this Province to the attention of outside entomologists and plant pathologists.

PAST AND FUTURE OF PLANT PATHOLOGY.

Melville T. Cook.

This subject can not be discussed properly without giving a considerable part of the time to the parent subject botany. In fact plant pathology is a part of botany and cannot exist without the nurture and care of the parent science. Neither is it possible to discuss the subject without giving some attention to

agriculture, much of which in its broadest sense is applied botany and which is becoming more and more dependent on plant pathology. Furthermore, it is an international subject and therefore, we will consider North America for the time being as the unit. Certainly the greater part of North America is a unit from the standpoint of race, language, and problems of public welfare.

Botany, the parent of plant pathology, is a very old science, possibly the very oldest of the sciences, although this statement will depend somewhat on our definition of a science and our ideas as to what may be looked upon as a beginning. Certainly it must have been the first science if the early efforts of the human race to protect and later to cultivate plants in order to maintain its existence or to contribute to its welfare and happiness may be called the beginning of a science. The very early written records of the human race contain reference to plants and to agriculture, but possibly the first great period in the development of botany began in Greece. Certainly it was the first great movement connected with our civilization. The early Greek and Roman scholars and philosophers studied plants with reference to both medicine and agriculture. Although confused with myths and superstitions of the age, many important ideas and facts were brought to light, such as Pliny's discovery of the value of legumes as soil improvers. In this connection, it should be remembered that the early Chinese literature also contains reference to the value of legumes for this purpose, but had no bearing on our own civilization.

Following this period of activity, there was little progress in botany until the last part of the 15th and early part of the 16th centuries, when there was a general revival throughout all western Europe. Lack of time prohibits a review of the Italian, French, German and English schools of this period; suffice to say that the prevailing idea was almost entirely utilitarian,—the study of plants as remedies for the ailments of the human flesh. Of course, a large percentage of these early students of botany were trained in the art of healing and from that time until comparatively recently, the men of the medical profession have been the patrons of botany. In fact the early history of botany in both the old and new worlds is interwoven with the early history of medicine.

The first efforts of this second period of activity in the study of plants were directed towards the identification of plants from the descriptions given by the Greek philosophers of the first period, but it was finally learned that the ancient workers were not familiar with and had not described all European plants; and also that many plants were not valuable in the practice of medicine. Therefore, the efforts of this second period were very soon directed towards describing and classifying plants. Out of this work came taxonomy, the alpha and omega of

botany. It is the very foundation of the science, but with the gradual perfection of the microscope, there arose another branch—morphology, which attracted the attention of many workers and reacted most favorably on taxonomic botany. It gave the key to the answer of many questions on structure, relationship, sexuality and spontaneous generation. Morphology was very quickly followed by plant physiology, a branch which involved amore intensive study of chemistry and other related sciences. Although the attention of these early students was directed primarily to flowering plants, they were not slow to recognize fungi and other non-flowering plants. However, their knowledge of fungi was meager and confused with superstitious ideas for many years. Fungi were supposed by many as late as the 18th century to be due to spontaneous generation. Nicander 185 B. C. said that they were "evil ferments of the earth". The Greek and Roman philosophers believed that fungi were produced by lightning and that corals were fungi turned to stone. The ideas of the 16th century were expressed by Bock (1552) who wrote—"Mushrooms are neither herbs nor roots, neither flowers nor seeds, but merely the superfluous moisture of the earth and trees, of rotten wood and other rotten things. From such moisture grow all tubera and fungi. This is plain from the fact that all the above mentioned mushrooms, those especially which are used for eating, grow most when it will thunder or rain, as Aquinias Porta says. For these reasons the ancients paid peculiar regard to them, and were of the opinion that tubera, since they come from no seed, have some connection with the sky; Porphyrius speaks also in this manner and says that fungi and tubera are called the children of the gods, because they are born without seeds and not as other kinds."

In the latter part of the 16th century (1591) Porta (a Neapolitan) came to the conclusion that all plants came from seeds, but the idea of spontaneous generation was so firmly fixed in the minds of the other workers that this view was not generally accepted until nearly 200 years later. It is unnecessary to say that the studies on the fungi up to this time were devoted almost entirely to the fleshy forms. The rapid development of the microscope during the 17th century enabled Robert Hooke, Malphigi, Leeuwenhook, Tournefort and others to extend their studies to the molds and other small forms, but did not overcome the ideas of spontaneous generation. The first great epoch in the study of fungi dates from Micheli, who in 1729 published the results on collecting and sowing the spores of many fungi. He obtained results which were remarkable when we take into consideration the crude methods he must have used. The studies of Micheli stimulated a new field of research which was given a new impulse by Persoon, De Candolle, Schweinitz, Fries and their contemporaries of the early part of the 19th century. They laid the foundations of modern taxonomic mycology without regard to existing or future economic relations.

Another great advance was marked by what may be called De Bary's rediscovery or demonstration of heteroecism among the rusts which he gave to the world in 1865. I say rediscovery because the relationship between the barberry and wheat rust had been suspected by farmers throughout Western Europe and had been demonstrated by Schoeler, a Danish schoolmaster, and published in 1818. Unfortunately Schoeler's paper did not attract attention and therefore the credit for this work is usually given to De Bary. In this connection it may be well to call attention to the fact that the Massachusetts colony passed a law in 1755 entitled "An Act to Prevent Damage to English Grain Arising From Barberry Bushes." The two forms of the rust fungus on the barberry and wheat were so unlike that the botanists were slow in accepting the ideas of Schoeler and De Bary. This was especially true in Great Britain, excepting for the studies of Marshall Ward and his students and Plowright, a physician of King's Lynn. In America, this line of work was taken up by Dr. Farlow of Harvard in 1880. However, by far the greatest progress in the study of mycology has been made within the past 75 years. The study of fungi, like the study of the flowering plants, had its beginnings in taxonomy—the chief corner stone on which we are now building the science of plant pathology. Furthermore, the development of mycology was dependent very largely on the development of the microscope during the preceding two centuries.

Although the rise of botany was due primarily to the medical profession the study of economic relationships during the latter part of the 19th century was decidedly in the back ground. Agriculture, much of which is in reality applied botany, was allowed to develop almost entirely independently of the mother subject. But it was during this period that our agricultural colleges and experiment stations came into existence and very rapidly developed into important factors in our educational, industrial and political affairs. In the establishment of these institutions, chemistry was preeminent; it was thought that the study of the chemistry of soils and fertilizers would solve all the problems of plant growth and crop production, and there are any who are still inclined to this view. It must be admitted that chemistry is the most advanced of the sciences and has done more towards increasing crop production than botany; and that the botanists have been all too willing to allow this condition to develop. However, botany was an active, although rather poor second in these institutions. In the beginning, it was usually combined with horticulture, a true branch of botany which very quickly developed into an independent subject, overshadowing the mother subject in many institutions in both activity and usefulness. This was followed by the development and separation of forestry, plant breeding and other divisions of botany. In some cases the

separation has been so complete that many people fail to see the connection or the necessity of a training in botany as a preparation for the more specialized lines of work. It appears to the writer that this is a great misfortune which must be corrected in the near future.

But let us return to the taxonomic study of the fungi, which from its beginning has been recognized as a division of botany and which has never been separated from the mother subject. The non-flowering plants were very mysterious to the early students of botany, and no very great advance was made with them, especially with fungi, until the microscope reached a degree of perfection which enabled the students of the subject to study the structure of the larger forms and to recognize the minute forms. Very naturally taxonomy was the first branch of the subject to be developed and this was followed later by morphology and physiology. The perfection of the microscope made possible the study of bacteria and the development of bacteriology, which may be considered a branch of botany. But it is a branch which very soon became more closely associated with animal pathology, abnormal physiology and bio-chemistry than with the mother subject. The development of these two branch subjects —mycology and bacteriology—became the foundation on which we are now building the superstructure—plant pathology. The sudden rise of plant pathology is due primarily to the extensive and intensive studies of the mycologists. In fact the plant pathology of to-day would be impossible if the were not for this mass of information, which has been accumulated by the mycologists of the past three-quarters of a century. These mycologists were well trained in botany and in most cases gave very little thought to the economics of the subject. They were what some people pleased to call "students of pure botany" but they laid the foundations for one of the most important divisions of applied botany.

Although plant pathology is of recent origin, it is just as difficult to say when it began as it is to designate the beginnings of botany. Plant diseases are referred to in the Bible, and in writings of the early Greeks, Romans and other peoples, but they were usually attributed to soil, climate, movements of celestial bodies or to some superstitions or supernatural agency. Strange as it may be, these same ideas are common within out own communities to-day The early study of the fungi did not contribute much to the study of plant diseases. However, several publications bearing directly on plant diseases came out during the latter part of the 18th and early part of the 19th centuries. The most important are *De Morbis Plantarum* by von Zellinger of the Austrian Tyrol in 1773; a second part of J. J. Plenck's *Physiologie et Pathologia Plantarum* in 1794; a work on diseases of fruit trees by J. M. Ritter von Ehrenfels

in 1795; *Pflanzen-Pathologie und Therapie* by Freiherr von Werneck in 1807; and a very comprehensive work by Count Re of Italy in the same year. Unfortunately they had no clear understanding of parasitism and therefore their work was of little importance. In fact the understanding of parasitism came rather slowly. During the early part of the 19th century it was first believed that the existence of parasitic fungi was conditioned by the host, that they were not reproduced by spores, but developed from fermenting sap of the host or from abnormal tissues. Finally when it became evident that they came from spores, it was believed that they were the products of disease, that their forms depended on the species of the host; or condition of host at time of infection. Efforts to control wheat rust by the enactment of laws were made in France as early as 1660 and in America in 1755. It is interesting to note that these same methods are being tried at this time. Treatments of various kinds have been used 150 years or more but with little success until the worker recognized the true causes of diseases. Two outstanding events did much to stimulate modern plant pathology. The first was the series of outbreaks of the late blight of the potato in Europe and America, especially the outbreak in Ireland which resulted in the famine of 1845. This demonstrated the importance of plants diseases as economic factors. The second was the discovery of Bordeaux Mixture in France in 1882 which demonstrated the possibilities of controlling plant diseases.

Having recognized and gained some knowledge of the causes of plant diseases; having learned something about the enormous losses in both wealth and human life due to them; having learned that it is possible to prevent and control them; the rise of plant pathology into a place of prominence and importance was inevitable. This rapid rise of plant pathology has made the botanical sciences more complex and more dependent on other sciences. The increasing population and the corresponding increase in the demand for agricultural products has forced the recognition of the importance of plant pathology in relation to crop production and to human welfare in general and has materially increased our responsibility to the public. It is estimated that the population of the Unites States will double within the next 100 years and that we will then have reached the limit that can be maintained by our own farm products. I suspect the same is true for Canada. Will the improvement in methods of controlling plant diseases reduce the losses, increase crop production and thus make it possible for North America to support a larger population than now estimated?

The very rapid development of plant pathology within the past few years has not been without its faults and dangers. Although the founders of plant pathology were well trained in botany, the same cannot be said of all the mem-

bers of the profession at this time. In fact we are already hearing complaints to the effect that many of the younger workers are very poorly trained in the fundamentals of botany. This criticism may be and no doubt is justifiable in many cases, but we must remember that the mother subject no longer consists of the single line of taxonomy, but of many lines such as morphology, physiology bio-chemistry and plant breeding. all of which are more or less important in the basic training of the modern plant pathologist. Furthermore the proper study of these lines makes it necessary that he study physics and chemistry. Possibly the practice of plant pathology makes it desirable that our workers should also be trained in horticulture, agronomy and related subjects. If so, the period of study becomes abnormally long as compared with the strand of human life.

What then must be the training of the plant pathologist of the future? Possibly before going farther we should define plant pathology. Perhaps the definition which would most clearly express the idea of most people who are familiar with the subject would be to say that it is the study of the causes, symptoms and control of plant diseases. You will note that plant pathology is used in a much broader sense than animal pathology. Plant Pathology is like medicine in that it has to do with the study of the causes, symptoms and results of control of diseases, but it is different in that it is concerned primarily with prevention rather than with the cure of diseases. At the present time, the demands of a rapidly increasing population for food, clothing and other plant products, and the development of an intensive agriculture to satisfy these demands, are emphasizing the importance of the prevention and control of plant diseases rather than the necessity for studying them. The result is that we are drawing on the great storehouse of information accumulated by the workers of the past much more rapidly than we are adding to it by our own researches. This is being encouraged by short-sighted legislators who appropriate public funds much more readily and more freely to the practice than to the study of plant pathology. The result is that in some cases extension men and others who have little or no training in the fundamentals of the subject are called on to practise plant pathology. In this connection we frequently hear the superficially trained workers making comparisons between the so-called practical and scientific, as though anything could be practical that is not scientific. There is no such thing as practical or successful agriculture or any other industry that is not scientific, although the operator may not be educated and may not appreciate that his methods are scientific. On the other hand the plant pathologists are frequently criticized because much of their work is hasty and superficial. This is due to the very great demand that is made on our workers for the control of plant diseases and is likely to continue unless something can be done to demon-

strate the necessity for more intensive and fundamental research. Investigations in plant pathology and contributing sciences must be encouraged if our North American botanists are to lead the world in plant pathology.

Those who view the profession from the outside may be impressed with the progress of this comparatively new branch of science, but those of us who are in the profession and see it from the inside get an entirely different view. We see before us the unexplored fields and the great possibilities. We see the great losses due to inknown or only partly know causes. We see many complicated problems which cannot be solved by any other than the untiring, well trained enthusiastic worker. We see the extremely difficult problems in fruit, field and truck crop diseases; we see the many untouched problems in diseases of ornamental plants, in the diseases of forest trees; the so-called physiological and environmental diseases; the diseases due to smoke and gas; the diseases following injuries due to insects and other organisms; the problems involving transmission of diseases; the problems involved in the study of soil organisms. Therefore, my appeal at this time is for the support of the research side of our profession; for a research that will lay a foundation on which we will build a more scientific and more useful plant pathology. My appeal is for the recognition of the superiority of scientific methods over empirical rules. My appeal is for the appreciation and support of the research man, who working faithfully in his laboratory or on a small plot of ground, seldom receives either the applause or the remuneration which are given to the practicioner of plant pathology or to the superficially trained field worker who imagines he is a plant pathologist but whose efforts would be impossible without the research with which he is so unfamiliar.

The demand for and the character of the work in plant pathology must convince all thinking persons that all plant pathologists cannot devote the major part of their time to research. We are rapidly coming to the same position as the medical profession, in which we will have our research workers, our experts or specialists and our practicioners; although the lines may not be rigidly drawn. The research workers will give the greater part of their attention to original investigation with possibly some time to teaching, they must have the very greatest freedom and must not be harassed by the demands for immediate results and applications. They must be allowed to work on fundamental problems involving taxonomy, physiology, culture methods, bio-chemistry, and other phases of the subject in which the relationship to control may be remote. The expert or specialist may devote the major part of his time to the study of a group of causal organisms, to a particular type of disease or to the diseases of some particular crop. He must be primarily a research worker and may or

may not give special emphasis to the applications and economics of the subject. The practicioner will be the man of the field, the worker who has to do primarily with the applications of the subject and who will also be an immediate advisor to the agricultural public. There will be no definite or fixed lines between these groups of workers, but they will naturally classify themselves to a greater or less degree. Each will give to and receive from the others, and the result will be the general advancement of the science of plant pathology and of agriculture.

The training of these workers will vary in degree rather than in kind. The research men must of necessity be thoroughly grounded in the mother science—botany, and in the various phases of other sciences, such as chemistry, physiology and zoology, which contribute to their proficiency. The specialists or experts must have the same groundwork with such other training as will make for success in their chosen fields. The practicioners may not be so thoroughly trained in the related sciences referred to, but they must have the groundwork and such training in horticulture, agronomy and allied subjects as will contribute to the success of control measures and crop production.

A knowledge of the taxonomy of both the host plant and the parasite must be the very backbone of the profession. We must know, we must understand so far as possible both the diseased plant and the cause of its troubles. Taxonomy may be prosaic and uninteresting to many, but it is necessary for the advancement of the science. Many of our present records are of little or no value because of incorrect determinations and many of the conflicting statements are due to the same cause. The solving of the taxonomic relationships of many groups, especially the ascomycetes and the imperfecti is extremely difficult, but it is necessary in order to solve many of our economic problems in plant pathology. This work will be materially aided by the introduction of modern culture methods.

A knowledge of the morphology and anatomy of both host and parasite is of as great importance to the plant pathologist as a knowledge of human anatomy to the surgeon. The work of Quanjer and Artschwager on the structure of the potato plant when infected with leaf-roll are good illustrations of this point. The plant pathologist of the future must know the morphology and anatomy of the host plant in both health and disease and this will lead to a development of that much neglected branch,—patho-anatomy. Furthermore, he must be familiar with the life history of both the host and the parasite in order that the treatment may be applied at the most critical period in the history of the latter, and that it may not be injurious to the former.

Many of our most serious diseases are due to fungi which live on more than one host plant, some of them having different stages which are very unlike. The wheat rust living on both the wheat and barberry, the white pine blister rust living on both the white pine and the currants and the apple rust living on both the apple and the cedar are well known examples of such fungi and there are no doubt many others that are unknown to us.

While it is true that in some cases we have been able to give successful treatments for certain diseases without knowing the life history of the parasite, it is also true that we have failed in many cases until this information was obtained. It is also true that many of our treatments have been improved as a result of increased knowledge of the history of the parasite. In reviewing the efforts at preventive measures for a period of more than 100 years we find that sulphur was frequently used with varying and uncertain results, partly because the workers of that time did not know how to prepare and apply it and partly because they did not understand the causal organisms. In fact in many cases they were ignorant of the presence of a parasitic organism. When practically all cereal smuts were known as *Ustilago carbo*, the results of the treatments were very uncertain, but when the species were separated and their life histories known, successful treatments were developed very rapidly.

Plant physiology is essential to the training of the plant pathologist because a diseased plant is one in which the physiological reactions are disturbed, regardless of cause; and because the plant pathologist is endeavoring to grow normal plants, i. e. plants in which the physiological disturbances are reduced to the minimum. A knowledge of plant nutrition was necessary for the development of plant pathology and an increased knowledge of this subject, of soil toxins, of enzymes, and of filterable and non-filterable viruses will prove the stepping stones of much of our future progress. Much of our culture work, our studies on physiological species, resistance to diseases, change in soil, moisture, temperature, and water levels will depend on our knowledge of plant physiology and ecology. De Bary was the first to clarify our idea concerning the relationship of parasite and host and although this has been the subject of considerable study, our knowledge of the exact physiological relationship between these two groups of organisms is extremely limited. In some cases the parasite is general, spreading throughout the entire plant. while in others it is restricted to certain organs or parts or organs. In some cases there is a clogging of water passages resulting in wilting, in others the excretion of poisonous substances, in others the absorption of water and food, and in others the dissolving of part or all of the cell wall.

Symptomatology is another phase of plant pathology which is very imperfectly understood. In some cases we have the destruction of parts or all of a plant, in others a dwarfing, in others an excessive growth, in others a wilting. This may appear a simple problem but diseases, like the plants which are attacked by them, are extremely variable. In fact so variable that a disease which is very destructive in one part of the world may be so insignificant in another part that its very existence may be denied.

Bacteriology, that branch of botany which was not only alienated from the mother science, but which became so closely affiliated with animal pathology and other sciences is becoming more and more of a necessity for a well rounded training in plant pathology. The honor of demonstrating bacteria to be one of the causes of plant disease belongs to the New World. Dr. T. J. Burrill of the University of Illinois in 1879 demonstrated that the pear blight was caused by bacteria. Since then it has been demonstrated that many important plant diseases are due to bacteria and I believe that I am safe in saying that North America leads the world in this line of study. However, the probabilities are that we have records of a very few of a very large number of diseases due to these organisms. Our knowledge of soil organisms, good and bad, in relation to disease and crop production is very meager and presents a most fruitful field for investigation.

The methods by which diseases are distributed are not nearly so well known as one would at first suppose. In a very general way we know that they are carried on seeds, on nursery stock of various kinds, in packing materials, in soils and manures, by wind and water, by birds, worms, snails and other animals. But the knowledge that certain mosaics are carried by insects and that cucurbit wilt is carried by hybernating beetles has aroused us to a realization of our own ingorance. In this connection, a study of zoology, especially entomology, becomes an important factor. Insects, nematodes, and other animal organisms are both carriers and causes of many diseases and this line of work must receive more attention from the pathologists.

No one who is familiar with the broad field of plant pathology in its relations not only to the mother science—botany, but also in its relation to crop production, transportation of perishables and international problems, will question the necessity for the most comprehensive training in the various divisions of botany and the related sciences, if the profession is to fulfil its obligations to the public. Although the progress in plant pathology may appear remarkable to the observer, the workers in the science know that the field is broadening and developing new relations unthought of by the founders of the

subject. Possibly no phase of the subject has received as much attention, after taxonomy, as the problems involving the life history of fungi, and yet we do not know the life histories of many of our most common species. A lack of this knowledge will no doubt explain our failure to control some of our most common diseases. Closely associated with these problems of life history are those involvlng the socalled "physiological species" or "strains", which are the continual sources of so much confusion. The study of these problems will necessitate improved technique in the handling of cultures and the making of inoculations, a knowledge of the factors controlling infections, the resistance to disease and the growing of resistant strains or varieties. These problems are united with bio-chemistry in one direction and with plant breeding in another. This line of work appeals not only to those who have that inborn love for the study of science but to those who are especially interested in the increase of plant production.

The diseases commonly referred to as yellows and mosaics have presented puzzling problems for more that 100 years and our progress has been very slow. We know very little about their causes, transmission or control. The recent demonstrations that some of them are carried in the weeds of the field without showing external evidence of their presence is encouraging. The solution of these problems necessitates technical training and skill of the very highest degree. The study of environmental factors, such as character of soil, temperature, other plants and insects, presents many problems which are almost untouched, but which will lead us into many fields of related sciences, such as biochemistry, soil-chemistry, ecology of plant life and entomology. This very naturally leads to geographical distribution and involves the workers to a greater or less extent in international problems.

The discovery of Bordeaux mixture in France in 1882 marks the first great step in the control of plant diseases, but by far the greatest progress in contol measures since that time has been made in the New World. We are now using many sprays and dusts for orchard, field and garden; we are treating seeds and soils; using many other methods which are familiar to this audience. But with all our progress, our treatments of plant diseases are far from perfect and present many problems for both the research and field workers Too much of our so called experimental work is nothing more or less than "cut and try" work without a scientific basis. Future research in treatment of diseases will involve a more thorough knowledge of the life histories of the causal organisms, of the host plant, and of chemistry; but will also bring the worker into close contact with the horticulturalist, the agronomist, the entomologist and the producer.

This leads directly to problems of storage and transportation which are receiving so much attention at this time.

Patho-anatomy is a field that is almost untouched. The proper study of its problems necessitates a knowledge of the anatomy of both host and parasite. While its economic bearings are indirect, it will no doubt react favorably on studies of the life histories of many organisms and indirectly on our methods of control.

Possibly one of the most far reaching phases of the subject is that of quarantine which immediately introduces interstate and international questions. Neither host plants nor diseases are respectors of international boundaries, of flags, or rulers or armies. They travel where ever the conditions permit and are frequently aided and abetted by the immediate commercial interests of the various countries. That our laws are imperfect, inefficient and frequently unjust cannot be denied by those who are familiar with the subject. The writer hesitates even to suggest a solution for these complicated questions,but certainly broader knowledge which can be gained only by international study and co-operation will prove helpful. Our quarantine laws are based on our knowledge of botany in general and our very imperfect knowledge of international plant pathology in particular. Our knowledge is not only imperfect, but provincial We must not only know more about the distribution of plant diseases, but we must know more about their symptoms and behavior under different conditions and also about the periods of incubation of many of them. A few years ago the United States Department of Agriculture was greatly exercised over the threatened invasion by the powdery scab of the potato and established quarantines which were vigourously opposed by Canada and several European countries. It is possible that a more thorough knowledge of the disease in question would have prevented much, possibly all of this annoyance to international trade. The international laws should be more uniform and there should be more international co-operation. Every nation in which agriculture is an important factor should have investigators in foreign countries and every nation should employ foreign experts to assist with various problems.

This leads us to make inquiry as to the efficiency of our present methods of education. The teaching of botany has changed very decidedly within the last half century. Fifty years ago there were very few departments of botany in the colleges and universities of North America; and in others botany was the tail piece in the departments of zoology which were masquerading under the name of biology. In fact this is true in some benighted institutions at the present time, The American botany of fifty years ago was little more than taxo-

nomy, the lines of development have been the same as in Europe; in the 80's morphology was making headway and in the 90's plant physiology was becoming a factor. During this early period, economic botany was being developed in the agricultural colleges and experiment stations by men who were trained in the universities. Even at the present time comparatively few of our workers in economic botany have received their elementary training in the agricultural colleges and the probabilities are that this will be the case for many years to come. Therefore, the obligations upon our universities is doubly great. They must train most of our botanists for all lines of botanical work. Unfortunately at the present time, applied botany is not fully appreciated by the agricultural industry, by the agricultural colleges or by the departments of botany in our large universities. Unfortunately many of our university professors are inclined to look upon plant pathology and other lines of applied botany as inferior, rather than as the climax or super-products of their own handiwork. They have forgotten that botany grew out of the medical profession and that Gleditsch, Martias, Caspary, DeBary, Sachs, Brefeld, Ward and many others who may be looked upon as master workman in the building of the science were interested in the applications of botany. They appear to have forgotten that the founders of economic botany in America were trained in our universities by Farlow, Atkinson and others whose names are deeply engraved in this history of American botany. In 1914, Dr. H. C. Cowles in his address as retiring Chairman of Section G of the American Association for the Advancement of Science said: "It would be a world tragedy if theoretical botany should die, or even if it were to be less influential than at the present time." In a recent address on "Trends of Modern Biology", Dr. Raymond Pearl called attention to "the fact that all of the activities of all living things, including man, are properly a part of biology in a greater or less degree; that the biologist may and probably does have something important to contribute towards the solution of the most various sorts of human problems, agricultural, medical, social, economic and so on." The development of applied botany if properly directed will do more than any other agency for the maintenance of theoretical or pure botany, but this will not be accomplished if our university departments of botany continue in their present attitude towards economic botany. It will be most unfortunate if the time ever comes when the research workers in plant pathology receive all their training in the agricultural institutions without being brought into closest contact with the university professors and the more strictly theoretical problems of botany. There are many problems in plant pathology that can be handled to much better advantage in our botanical gardens and large universities which are not connected with the agricultural institutions.

The reformation must begin in our undergraduate courses and extend into the graduate schools. At the present time, botany in the agricultural

colleges is too often overshadowed by horticulture and agronomy, and promising students go into these lines of work; while in many of our colleges which are not agricultural, the students are drilled in technical features of the subject which have little or no interest or meaning to them. Here, then is the greatest opportunity for the university department of botany.. All beginning students should be given, not only the subject matter of the course, but the broadest possible view of the subject as a whole in all its relations to other sciences, to human welfare and to the wealth and progress of the nations of the world. Fortunately the American Phytopathological Society has not broken away from the mother science. We hold our meetings at the same time and in some cases hold joint meetings with section G of the American Association for the Advancement of Science and with the Botanical Society of America. We co-operate with the mother subject to the fullest extent. We are also in close contact with the agricultural industries. Therefore the conditions are most favorable for the future development in the New World of the highest possible type of botany in general and of plant pathology in particular.

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SOME NOTES ON SPRAY MATTERS.

By L. Caesar, Provincial Entomologist, Guelph, Ont.

Spraying Currants to Prevent Defoliation.

In Quebec as in Ontario it is probably a common occurrence for currant bushes, especially black currants, to lose all or nearly all their foliage prematurely, the defoliation sometimes occurring in July even before the fruit is picked and sometimes in August.

The chief cause of this leaf drop, so far as my experience goes, is the leaf spot or anthracnose disease (*Pseudopeziza ribis*, though the other common leaf spot (*Mycosphærella grossulariæ*) may also be a factor.

The condition favouring leaf spot is wet weather. If much wet weather occurs in May or June there is almost sure to be a heavy defoliation often as early as the end of July, especially the weather that month is hot and dry.

Having observed this defoliation of black currants for several years and believing that serious loss to the vigor and yield of the plants must result there-

from, I seized the first opportunity which presented itself of testing whether spraying would prevent the leaves from falling. This oportunity came in 1919.

That year at Burlington a field of black currants was divided into six plots. One plot was treated with Bordeaux, another with lime-sulphur, another with soluble-sulphur, another with copper-lime dust, another with sulphur-arsenate-of-lead dust, and the remaining one left untreated as a check. Three applications were given to each of the five plots and half of the Bordeaux plot received and additional fourth spray.—The first application was when the leaves were about three-quarters of an inch wide; the second soon after the blossoms began to appear; and the third when nearly all the bloom was over. The fourth spray on half of the Bordeaux rows was given two weeks after the third.

The results were interesting not only to myself but to all others who saw them! The check rows and all the rows except those on which Bordeaux or lime-sulphur had been used had lost practically all their foliage by the end of the third week in July; at which date the fruit had not yet been picked. The lime-sulphur row was badly affected with leafspot but most of the leaves remained on until August. The Bordeaux rows retained their foliage not only throughout July and August but up to the end of the season. The half of this plot which had received four applications had better foliage than that which had received only three applications but the difference was scarcely great enough to justify the extra spray.

The next spring the plots were again examined just as the buds were bursting. The benefit from Bordeaux once more showed up in a conspicuous way for the buds on this part were all green and bursting, whereas on the other plots fully half were dead. This was due to the fact that the Bordeaux rows by retaining their foliage had been able to supply the necessary food throughout the growing season to put the buds into proper condition for winter and for the next spring, whereas the check and other rows in consequence of losing their foliage early had not been able to do this and so the buds had been starved and died.

As one would expect the benefit of the Bordeaux spraying showed up also at the time of harvesting, for the only rows worth picking were those on which Bordeaux had been used.

In 1920 another spray test in a different field was made but that year the season was unfavourable for the development of disease and in all cases foliage held on fairly well through the season. Bordeaux rows, however, even under these conditions had in my opinion sufficiently better foliage to justify the spraying.

I feel satisfied therefore that to get the best results from his currant plot, especially from black currants, the grower should keep the foliage well sprayed with Bordeaux throughout the months of May and June or in other words until nearly the time when the fruit is ripe. The greater vigor of the plants and the increased annual yield will much more than pay for the material and time required in spraying.

No poison need be used on black currants, because the currant worm does not attack this variety. However on red currants poison should be added to the second application to destroy the worms.

Value of a Casein-Lime Spreader.

Casein-lime spreaders, especially the brand known as Kayso, were widely advertised last year and were tested by many experimenters almost all over North America. I used Kayso along with lime-sulphur and arsenate of lead on about 75 McIntosh and Fameuse trees in Norfolk county and in doing so followed closely the directions of the manufacturers. The substance mixed well with the water and the other spray ingredients and gave evidence of being a good spreader. It was used first in the spray just before the blossoms opened and then in the one just after the blossoms fell. On examining the leaves soon after the spraying was done, one felt well satisfied that the spreader had helped to make a thorough job and had given a more uniform covering then would otherwise have been the case; but ten days after the later spray the orchard was again examined and the leaves on all four rows found to have numerous small brown specks which were clearly due to the Kayso, as the leaves on trees along side in which this substance had been omitted had no injury. So numerous were these spots on the Kayso rows that I felt that another application of this substance would be altogether too dangerous, and so it was omitted in the next spray.

The codling moth was so well controlled all over the orchard by all mixtures that no conclusions can be drawn as to the value of the spreader in the control of this pest.

Early scab, that is scab which developed before the first of July was well controlled on the rows in which the spreader was used but the difference between these rows and those alongside was only approximately 1%, this being in favour of the Kayso.

In addition to my own results I learned at Rochester in January the results from this spreader obtained in New York. The Entomologists there were agreed that the benefit from casein-lime spreaders was so small that it would not pay for the extra expense incurred in purchasing the material.

In New York they had no injury from burning but in a number of other places in the United States burning did result just as it did with me.

My conclusions therefore drawn from my experience and that of several other entomologists are, that if spraying of apples is well done, the spreader is not necessary and will not pay.

Dry Lime-Sulphur as a Substitute for Liquid Lime-Sulphur

The Canada Paint and Sherwin Williams Company are selling a dry lime-sulphur which is in the form of a fine orange-yellow powder which dissolves readily in water. When arsenate of lead or arsenate of lime is added to the mixures the colour still remains a much deeper yellow than in the case where liquid lime sulphur and these poisons are mixed together.

I tested this dry lime-sulphur this year on seventeen McIntosh trees, using it not at the strength which the company recommends but roughly at a strength worked out in conjunction with our chemist after he had made analysis of the substance. In the first application I used 6¼ pounds to 40 gallons of water and applied it soon after the buds had burst; in the second application 5 pounds were used and applied just before the blossoms opened; and in the third application 4 pounds and applied just after the blossoms fell. One pound arsenate of lime and 4 pounds hydrated lime were added to every 40 gallons in the 2nd and 3rd applications.

Though the conditions were very favorable for scab the trees sprayed with this substance were just as free from the disease up to July 1st as those sprayed with the liquid lime sulphur, the average scab on this row and the rows alongside being a little over 3%. But after July 1st there was a decidedly heavier outbreak of late scab on this row than on any other of the 32 rows in the orchard. This would tend to indicate that the spray did not adhere so well or have such a lasting effect as the liquid lime-sulphur. Yet perhaps it is scarcely fair to draw definitie conclusions from one year's expprience.. However as dry lime sulphur is a very convenient type of spray material I believe we ought to test it out further and see whether at a greater strength it will prove satisfactory. It would be especially convenient for owners of small orchards or of a few trees in a garden and would be sold by merchants in small towns who would not handle the liquid mixture.

. . . .

Mr. Petch—Dry lime sulphur has given me very poor results.

Mr. Caesar—What strengths did you use?

Mr. Petch—The strengths recommended by the manufacturers.

Mr. Caesar—I think that in the past these have been too weak.

The Comparative Susceptibility of McIntosh and Fameuse Apples to Late Attacks of Scab.

I have usually considered that there was not much difference in the susceptibility of McIntosh and of Fameuse apples to this disease, both being well known to be very susceptible I am still unable to say whether there is any difference in their susceptibility to early attacks of the disease, because ordinary spray mixtures if properly applied will control the scab on either variety; but this year in a ten acre orchard consisting of alternate row of McIntosh and Fameuse I discovered a distinct difference in the degree of susceptibility to late infections.

The whole orchard received the regular three sprays and in addition part of each variety received a fourth. On both McIntosh and Fameuse the scab was fairly well controlled in the early part of the season, there being an average of slightly over 7% on the McIntosh and slightly under 7% on the Fameuse. As check McIntosh trees lost every apple and had most of their early leaves destroyed by the scab the year was clearly very favourable for the disease. After the first of July a late infection began in the orchard due to wet weather the last week in June and also later in the season. Under these conditions I was surprised to find that the McIntosh proved much more susceptible to the disease, the total late scab on Fameuse being 24.2% and on McIntosh 66.6%; that is, McIntosh were nearly three times as badly affected as Fameuse under exactly the same conditions of weather, soil and situation. This is a striking difference and the conclusion one is forced to draw is that we must use more vigilance in a wet season to keep McIntosh free from disease than Fameuse.

When Shall we Apply the First Spray to Apple Trees?

A very important question is—When should we apply the first spray in apple orchards in which there is no San José Scale and not much Oyster Shell Scale or Blister Mite?—a condition which must be common in Quebec.

A study of the life-history of the fungus would indicate that there is little value in spraying for this disease before the buds burst and that we should wait at least until the bursting has taken place and green tissues are exposed to infection. But there are green tissues exposed to infection from the time the buds are bursting until the regular pinkspray is applied just before the blossoms open; moreover, as the leaflets keep increasing in size during this period and the blossom bud clusters begin to push forth towards the end of it, it is impossible for any single application, no matter when applied, to give complete protection throughout the period.

Theoretically the ideal course to follow would be to have the weathermen warn us at least two and better three or four days ahead that a spell of wet weather is coming and to have the fruit grower take advantage of this warning and spray at once. Unfortunately the weathermen can seldom predict the weather so far ahead. There is also the further difficulty that even if they could there would not infrequently be more than one such spell, thus requiring more than one spraying. Now so far as I can judge it would be difficult to convince our fruitgrowers that they should give more than one spray before the pink spray for experience seems to show that more than one would seldom pay. So that the question comesdown to, what time should the first spray as a rule be given to secure the best results.

Many answer this by saying "Spray when the leaflets are the size of a mouse's ear." This has worked fairly well but I believe that, inasmuch as our main object is to keep the fruit protected it would be wiser to direct our growers to postpone the spray just as late as possible and yet be able to finish it before the pink spray should begin. So my suggestion would be to wait until the blossom-bud clusters have appeared on the earlier varieties and are just beginning to do so on most of the later ones. By spraying them we should be taking the earliest opportunity to protect the fruit itself from scab; for the bases of these blossoms develop into the fruit itself and so an infection on them means a scabby apple. This late date of spraying would some years allow some danger of the leaflets becoming infested before the application was given, but the infection would seldom be great and it seems to me safer to risk leaf infections than fruit infection.

There has occurred to me a possible alternative in the nature of a compromise between this late date of spraying and spraying soon after the buds burst; namely, to spray the whole orchard from one side, with the wind, as soon as the buds have burst and the leaflets are just beginning to appear and in doing so to try to cover most of the tree by stopping just as you come to it and shooting the spray all through it in one definite direction and then, after driving just past the tree shooting the spray back all through it in a direction about right-angles to the first direction; then after this application to wait until the blosson-bud clusters, as said above, were appearing and spray the opposite side of the tree in the same thorough manner.

Some would call this two applications but if so they would take very little more time than an ordinary spray and would not only protect the fruit but do much to protect the foliage also.

I am throwing out these suggestions with the hope that by further experimenting we may be able to improve upon our recommendations to fruit growers.

It is scarcely necessary to state that if lime-sulphur is used for this spray it need not be stronger than about 1 gallons to 35 gallons of water and no poison would ordinarily be required.

If dust is used instead of liquid I think I should be guided largely by the weather, I should dust first whenever wet weather threatened after the buds had burst and leaflets were beginning to show and then give another application when the blossom-bud clusters were appearing.

DUSTING VERSUS SPRAYING.

By G. E. Sanders, Deloro, Ont.

The question of dusting versus spraying is one that continues to be discussed at every Horticultural Meeting just as twenty years ago no Entomological Meeting was complete without a discussion as to the relative merits of Paris green and lead arsenate. Twenty years ago, there were certain places where Paris green was superior to other poisons then on the market. So with liquid spraying today.

I have probably conducted as many small plot tests of liquid and dust spraying experiments as any man in this room and have visited almost as many fruit sections and orchards as any of you during the past three years and I want to say to you that when experimental plots, say even acre plots, begin to run within five per cent of each other in insect or fungus control, then, it is beyond the power of the experimenter to say from data obtained from his own plots which material is going to give the cleanest fruit when placed in the farmers' hands.

In a number of reports I have published the data gathered by Prof. H. H. Whetzel of Cornell which gave a summary of 4 years' dusting in New York, Nova Scotia, Illinois and Michigan, a total of 16 years' experiments, comparing the fungicidal value of sulphur dust and lime sulphur spray. By a singular coincidence, this data averaged the same to one-tenth of one per cent in apple scab control. This data was all secured by professional experimenters, some of whom had good dusting machines and some poor; some had good spraying machines and some poor ones. On the whole, I have found that experimenters spray more efficiently than the average farmer while they do not dust nearly as efficiently. They usually do their dusting on the same days as they do their spraying regardless of weather conditions, and often, owing to the indefinite relations between the experimenter and the orchard owner's hired man,

the experimenter does not dust so early in the morning as the average grower.

Last year I came upon a new type of data. One of the bankers in Williamson, N. Y., decided that he would find out how dusting really worked out. He sent a man to every grower shipping apples into Williamson and got the full data on material used, average crop and pack out of the fruit.

Pack out of all apples shipped through Williamson, N. Y., Season of 1921-22.

No. of Orchards	*Total No. acres*	*Treatment*	*Percentage "A" Grade Fruit*
32	1.011	Dusted	48.6
247	3.348	Sprayed	11.4
34	149	Untreated	1.1

This is rough data and some of the sprayed orchards gave excellent fruit and some of the dusted ones poor fruit, but there are some things here that cause us to wonder. We find here that the growers are not getting the same relative results from spraying and dusting as the professional experimenters are getting. Apparently the farmer is not doing his spraying as thoroughly as the experimenter and he is doing his dusting a little better. These differences in results make us wonder whether we would serve the country better by advocating dusting or by advocating spraying.

Some of you may say, "That is the opinion of a dust enthusiast who is now manufacturing dusting material". That is true, but let me tell you that for immediate profit there is more money to be made is Paris green, a material that we manufacture and do not recommend, than in all the dust that has ever been made. We have to manufacture what the public demand. In such a gathering as this I try to recommend what I think is best irrespective of the profit that may be in it.

The question of dusting vs. spraying is one that the farmer has been forced to settle and is settling to his own satisfaction since experimental data is not proving to him an accurate guide as to what he can accomplish in his own way in his own orchard.

I think that I am safe in saying that 95 per cent of the experiment station workers refuse to recommend dusting yet. I know of numerous questionaires that have been sent out to orchardists who are dusting and invariably over 95 per cent of the users have expressed themselves as satisfied with the method. On a recent questionaire sent out in the United States 97 per cent of the owners of dusters stated that they intended continuing dusting. There is

cause for some pretty serious thought in these differences. Are the experimenters falling down in their dusting operations? Are the experiments not being conducted in a way that makes the results applicable to orchard conditions? Or are the experiment station men doing their spraying much better than the farmer and doing their dusting no better than the farmer?

Personally, I think that the greatest cause for these differences is the fact that the average farmer will, if anything, both time his dusting better and apply his dust better than the experimental men, and when spraying he will not do anything like so thorough a piece of work

The big objection to dusting has in the past been the cost of materials. Everyone agreed that dusting saved eighty percent of the time of application, the initial cost and depreciation of the machinery was lower and the life of the machine twice as long, the weight of the machine much less, making it more desirable on both hilly and wet ground, and the results obtained satisfactory to farmers. The price of dusting material has in the past been high,—about double the cost of spraying material, and has been the one big obstacle to the spread of the method. In 1918, the introduction of Blue Copper Arsenic dust, which is made up of monohydrated copper sulphate, hydrated lime and arsenate of lime, lowered the cost of dusting materials so that, reckoning the saving in time and equipment, the total cost of dusting was brought below the cost of liquid spraying. This year, for the first time in the history of dusting two dusts are on the market that cost the grower about the same as the materials for liquid spraying. These are what we term Brown Copper Arsenic dust and Green Copper Arsenic dust.

Brown Copper Arsenic dust in the formula 4½-2, which is used on apples, contains 18 lbs. of copper sulphate crystals and 8 lbs. of arsenate of lime in the hundred, the remainder being made up of hydrated lime. Green Copper Arsenic dust, in the formula 9-5, which is used on potatoes, contains 36 lbs of copper sulphate crystals and 5 lbs. of metallic arsenic in the form of arsenites, or the equivalent of either twenty-five pound of arsenate of lead or twenty pounds or arsenate of lime in the hundred, the remainder being made up of hydrated lime. These dusts are being retailed in both Canada and the United States at approximately the same price as the farmer can buy the equivalent amounts of copper sulphate, lead arsenate and lime for makingliquid Bordeaux, thus making dusting materials, for the first time, as low or lower in price than the materials for liquid spraying. This removes the greatest single objection to dusting. Both these dusts will be largely used commercially this season and their exact status as fungicides and insecticides determined.

Nicotine Dusting.

During the past six years, great changes have been made in nicotine dusting. The first nicotine dust made by Prof. Smith of California was nicotine sulphate sopped up in dried china clay. The nicotine in this material was almost completely non-volatile and, in view of our present knowledge, it is a wonder that dusting with nicotine ever got by the initial stages. Luckily it was used first on the walnut aphis, which is very easy to kill and the thick foliage of the walnut tree held what vapors were liberated until they had done their work. On almost any other insect or on any other type of tree the original nicotine dust would have been branded a failure. There is a lesson here that should prevent us from forming too hasty judgments on new materials. Later, some one found that the addition of a small quantity of lime made nicotine dust more effective. Then some one found that it was the volatile nicotine that did the killing, that nicotine dusting was gassing or fumigating and that it was not necessary to actually hit the insect with the dust in order to make a kill.

During the winter and spring of 1921-22, Dr. Headle of New Jersey began a series of experiments on the rapid volatilization of nicotine from dust. The Headle dust formulas have increased the value of nicotine dusting materials by from five to twenty times, depending on the honesty and intelligence of the various commercial concerns applying them. Let me illustrate.

On the whole, dusting has made remarkable progress during the past season, for the most part on its own merits. The highest yielding potato field on Long Island was a dusted field. Potato dusting on Long Island and in Maine was fully as satisfactory as spraying, while in Florida it surpassed spraying on account of the extra stimulation resulting from the dust. Where at the beginning of last season one dusting machine was working on citrus in Florida, by the end of last season one concern had sold 109 power dusting machines in Florida for citrus work. This year the same concern is placing over 100 power dusting machines in one county in Florida.

In Nova Scotia they bought 200 more dusting machines last season, dusted 80 per cent of the crop and grew the cleanest crop as well as one of the largest crops since 1911. Since Nova Scotia took to dusting in a large way in 1919, they have grown four large, continuous crops that have averaged more than double the average of the previous seven crops when they were spraying with lime sulphur.

At the meeting of the New York State Horticultural Society two months ago, the evidence of the growers was all in favor of dusting, the largest growers in New York State, Collymer Bros., stating that if they had dusted their entire

crop they would have had 5,000 barrels more fruit and 20 per cent more of that "A" grade.

Nicotine dusting has progressed to such a point that outside of the scale insects, dusting gives much more satisfactory control of sucking insects than spraying. Such insects as pea aphis, which could never be satisfactorily controlled by spray, are now easily controlled by dust.

Last spring the best nicotine dust was one containing a total of 6 percent of nicotine sulphate or 2.4 percent of nicotine. Of this 3.75 percent of the nicotine present was volatile, or the total dust contained 0.09 percent of volatile nicotine. This dust did fair work in the control of moderately resistant insects. By the end of the season dusts containing a total of 2.4 percent of nicotine and 0.26 percent of volatile nicotine were on the market. This last dust contained slightly less than three times as much volatile nicotine as those sold earlier in the season, but in practice one-fourth as much dust per acre gave better control of sucking insects than did the earlier dusts. Today the Headlee idea is being applied with the result that dusts are being made with from 40 to 60 percent of the total nicotine in highly volatile form. I know of one dust in particular that is being placed on the market which only contains a total of 2.0 percent nicotine but 60 percent of the nicotine, or a total of 1.2 percent of the dust, is volatile nicotine. This dust contains less total nicotine, yet it is over twelve times as valuable per pound as the best dust on the market at the beginning of last season and twenty times as valuable as others.

On ground crops you can increase the efficacy of nicotine dusting by dragging a sheet for twenty feet over the crops, tying the sheet to the boom, thus confining the fumes. This almost doubles the value of a nicotine dust.

At the end of 1922 nicotine dusts were successfully controlling such insects as pea aphis, potato aphis, pear psylla and other insects that have in the past been almost immune to the former nicotine dusts and very difficult to control by spray.

There will, in the future, be many arguments pro and con on dusting but as I see it the dusting method is going to win, perhaps slowly, but it will win in spite of anything that can be done to prevent it. The low cost and low upkeep of a dusting machine, the speed of application, the low-priced dusting materials now available and the fact that the average farmer makes a better job of dusting than he does of spraying are factors that are going to cause dusting to increase.

It is impossible for dusting to succeed with high-priced dusting materials, but it has been my experience that just as soon as the cost of dusting is made approximately the same as the cost of spraying, the growers are going to dust instead of spray. Whether they get a few more or a few less No. 1 apples

or whether they get a trace of net russetting does not count and all of the evidence that I have goes to show that the average grower or the average locality will grow more and better apples by dusting than by spraying because the average grower will dust more thoroughly than he will spray.

I want you to understand that I am not questioning here the accuracy of the data that has been submitted by official experimenters nor am I questioning the honesty or sincerity of experimenters, either individually or as a class. However, I am convinced that the average farmer will get better comparative results from dusting than will the average experimenter.

PROVANCHER THE CANADIAN LINNAEUS.

HIS LIFE AND WORKS.

By Georges Maheux, provincial entomologist, Quebec.

During the last five years, Canadian naturalists and scientists have heard more about Provancher than during the previous quarter of century, Scientific societies, reviews of all kinds and even the daily papers have in succession paid warm tributes of admiration to the high value of the late Abbé Provancher as a priest, citizen and naturalist.

One day, in August, 1918, a large group of friends, admirers and disciples gathered in the Provincial Museum at Quebec. The object of the meeting was the celebration of the 25th anniversary of the death of Provancher and the unveiling of a tablet presented by the Quebec Society for the Protection of Plants and bearing the folloing inscription.

A la mémoire de Provancher, Naturaliste et Entomologiste, 1820-1892.

A few months before, in the church of Cap-Rouge, where the remains of Provancher have been piously kept, Canon Huard erected another memorial with the financial aid of the Ontario Entomological Society and numerous other institutions. Nevertheless, all the publicity accorded to the name of Provancher fails to give anything like a complete idea of his career; the entomologist regards him as an entomologist, the botanist as a botanist, while the man was really the Linnaeus of Canada; that is to say a true naturalist in the broadest sense of the word, having been interested in and written competently on the various kingdoms of Nature. The complete list of his works reveals

a great similitude with Linne's Systema Naturea, at least, as to the subject treated and the division into classes, orders, genera and species. The resemblance is much more striking when we come to compare the means of study followed by both naturalists, though separated by more than a century of marked progress in the field of natural sciences. Like Linnaeus, Provancher might have said at the end of his life: "Ea quæ Facimun sunt pars minima eorum quæ ignoramus", but know that his life was well filled and that his work added substantially to the sum of human knowledge.

Born at Bécancourt, province of Quebec, on March 10th, 1820, Provancher received his education in the newly erected college at Nicolet. There, under the shade of lofty pines, he picked up some flowers which determined his passion for the things of Nature. There on the dusted shelves of the library he discovered, by chance, an old text-book of botany that helped him greatly in his new studies. These studies were quite private, for until about 1835, the teaching of natural sciences was still in the womb of the future.

At the end of his classical course, in 1840, Provancher decided to become a priest and he refrained for a while from his scientific ambitions. He occupied various positions in many parishes between 1844-1847. In 1847, he devoted himself to the service of some hundreds of Irish immigrants, stricken down with an epidemic of typhus. His heroism upon this occasion gives an idea of his unselfish character. Though nervous and rather irascible, he concealed under a coarse appearance the heart of a true friend, always frank and generous.

The active scientific life of Provancher began in 1848 with some essays on grafting that met at first with failure, but that brought back his attention to botany through the channels of horticulture. When transferred, in 1855, to St. Joachim at the foot of Cape Tourmente, Provancher was chiefly interested in botany and we see from his writings in various papers that he strongly advocated the teaching of natural sciences in all schools. To give a proof of his convictions along these lines and to help to realize this plan, 3 years later he published a "Traité élémentaire de Botanique" which was soon adopted by numerous educational institutions.

With this first production Provancher took rank among educators. In 1859 his " Tableau chronologique et synoptique de l'histoire du Canada" was published with the same object in view. While at St. Joachim, Provancher with his devouring activity, commenced experiments on the varietal resistance of fruit trees that can be grown successfully around Quebec. In the newspapers of those days he wrote many articles to convince the farmers of the necessity and advantage of growing fruit trees. His untiring efforts resulted in the planting of a very large area with apple and plum trees, most of which lasted over half a century, the last survivors being killed a few years ago by a severe winter.

Transferred to Portneuf, in 1860, Provancher continued his Horticultural experiments with great success even establishing a fruit tree nursery for the advantage of the farmers of this county. Two years later, he was ready to make known the results of his experience as a fruit grower. How new work published in 1862 and entitled: "Le Verger Canadien" has been until lately the classic guide of fruit culture in the Province of Quebec. This little book reached its fifth edition in 1885;; for the economic entomologist it contains a very interesting section, namely the chapter dealing with the insect pests of the orchards and describing the means of controlling them. This was, in all probability one of the first expressions of applied entomology ever presented in book form in Canada. But it is not the first in date. Provancher was known almost exclusively as a systematist; nevertheless, the first paper he published in his life was a discussion on "Insectes et maladies nuisibles au blé" an essay prepared for a competition on this subject organized by the Department of Agriculture for which Provancher received a third prize (under the nom de plume of Emilien Dupont).

The first important work of our great naturalist was published in the year 1862: it is the voluminous "Flore Canadienne", the first and only complete work dealing with Canadian plants. Heretofore, no other worker has dared undertake the gigantic task of revising and completing this now old treatise.

Every Canadian and American entomologist knows Provancher as a pioneer entomologist, and it is as such that he merits fame. His systematic classification of insects modestly entitled "Petite Faune Entomologique du Canada" fills four compact volumes making a total of 2506 pages as follows:

Vol. I.—Coléoptères and additions.
Vol. II.—Orthoptères, Nevroptères, Hymenoptères.
Vol. III.—Hémiptères.
Vol. IV.—Additions and corrections to Hymenoptères.

There may be found the description of all the Canadian species contained in his collections, many hundreds of which were unknown to science. In the order of Hyemoptera alone, Provancher described 923 new species. Rohwer and Cahan, of the Washington Bureau of Entomology have pronounced the accuracy of his descriptions and pointed out some mistakes in referring species to the wrong general.

From 1868 until his death in 1892, Provancher devoted much of his time and resources to the maintainence of his review" Le Naturaliste Canadien". The editor filled with his own pen most of the 20 volumes of this publication (nearly 8,000 pages). Apart from insect studies that were later published in book form, this collection contains an elaborate classification of vertebrates, a study on the birds of Quebec, vermes, etc. A volume on Mollusks was

published about 1888 and two years later 2 volumes of travels, one to Jerusalem, the other to the West Indies.

Besides all these occupations Provancher found time to contribute regularly to such weekly papers as "la Minerve" and "La Gazette des Campagnes". These articles discuss a great variety of subjects especially agricultural and educational. Sometimes he severely criticized public authorities, for instance when the government cut off the annual grant given by previous administrations for sustaining the "Naturaliste Canadien". The life of the publication was seriously menaced three times by such decisions; in 1880, 1883 and again, in 1890.

Provancher's activity never knew any limit and left its distinctive mark in many fields. He was known as a very successful organizer, as well in building churches, in organizing two Canadian pilgrimages to Jerusalem and as the promotor of a steamship company, etc.

In 1888, he started a new publication, "La Semaine Religieuse" a weekly review that is still in existence. During his life he had the pleasure of seeing a large group of learned men interested in natural sciences, many of them being his own disciples, whose studies he directed personnally. Such were: Canon Huard, his successor as editor of "Le Naturaliste Canadien" and now curator of the Public Museum, Quebec; Abbé Laflamme, late professor of Natural history at Laval University and a geologist of wide reputation, F. X. Bélanger, entomologist, late curator of the Zoological Museum of Laval University; Dr Crevier, microbiologist; Dr St-Cyr, geologist and many others.

When Provancher died at Cap Rouge, March 23rd, 1892, at the age of 72, he could see the realization of the dream of a life time; the natural sciences being then taught in all the colleges and many young men interested in various branches of nature study.

He has been honored by Laval University with the degree D.Sc.; he was a charter member of the Royal Society and member of man European and American scientific societies.

His three collections of insects may be found at the College of Levis and at the Quebec Public Museum. All other specimens collected by Provancher have been kept with care by Rev. Canon Huard, who for the last 30 years has kept alive the memory of the Canadian Linnaeus.

PLANT DISEASES OF 1922 IN WESTERN QUEBEC.

By B. T. Dickson.

In presenting this account of the plant diseases observed during the season of 1922 the writer feels impelled to explain that the lack of more exact data regarding prevalence and economic importance is due to the author's undesired vacation in hospital. It is felt, however, that even a somewhat fragmentary account is of value in helping to survey the Dominion as a whole. I wish to thank Mr. J. G. Coulson of this Department for obtaining much of the information herein recorded.

Potato.—Early blight (*A. solani*) was quite common and in August-September the foliage was considerably spotted. The spots were not large and rarely coalesced and it is not likely that the resulting loss in yield was appreciable.

Late blight (*P. infestans*) was not seen to any extent.

Mosaic was present, as was Leafroll, but not serious, although aphids were found in numbers during mid-October.

Hopperburn was prevalent during September and leaf-hoppers were common on late varieties.

Black dot disease.—This disease, which is being studied by the author was of frequent occurrence during the latter part of this season. In some fields it was present to the extent of 5%. It is impossible to say yet whether it causes serious injury but it was usual to find affected plants dying down two or three weeks earlier than healthy ones in the same plot. The root systems, stolons, and ground-level stem tissues are attacked and killed. The development of tubers depends upon the stage at which the stolons are affected. Many tubers with the black-dot sclerotia on the surface were found.

Tomato.—Mosaic was present but not to the same extent as during 1920 or 1921.

Leaf blight, caused by *A. solani*, was very common during late August and September and spotting of the fruit with a subsequent rot occurred in September.

Bean.—Anthracnose (*C. lindemuthianum*) and blight (*Ps. phaseoli*) were prevalent, the season being ideal for their development and rapid spread

Mosaic less noticeable although frequent.

Stem-rot and wilt caused by *S. libertiana* was of local occurrence but quite common.

Pea.—Mosaic was found in rather isolated areas but Stigmonose caused by *Macrosiphum pisi* was the cause of heavy losses in late crops.

Pod spot (*Ascochyta pisi*) was common.

Cucumber, Melon, Squash.—Wilt caused by *B. tracheiphilus* occurred in practically every plot. The wilting was of the slow-developing type.

Onions.—Onion smut (*U. cepulæ*) was serious in several large areas near Montreal.

Downy mildew (*P. schleideni*) occurred in isolated areas and while it alone was not serious greater loss was sustained because it was followed rapidly by *Botrytis sp.*

Pink-root or root-rot (*F. malli*) was present and serious and again the wilted leaved were attacked by *Botrytis sp.* and the loss aggravated.

Celery.—Leaf and petiole blight (*S. petroselini apii*) was common and serious on Paris Golden but Self-blanching was only slightly affected.

Clovers.—Powdery mildew (*E. polygoni*) was present to an astonishing extent—fields of clover (*T. pratense*) looking as though powdered with white flour.

Mosaic was again common in certain areas.

Sooty spot (*Polythrincium trifolii*) was of frequent occurrence but did not cause any perceptible loss.

Cereals.—Oat smut (*U. avenæ*) and barley smut (*U. hordei*) were present.

Stinking smut of wheat (*T. tritici*) was found in isolated cases but was not serious as was also the case with Loose smut (*U. tritici*).

Fusarium blight in heads of rye and wheat is apparently commoner than expected and a similar blight in corn was not difficulte locate as a rule.

Ergot of rye and timothy was note as rather more prevalent than usual.

Sunflower.—Samples of sunflower stem suffering from Sclerotinia rot and wilt were sent in from all parts of Quebec indicating its widespread occurrence It has been impossible to ascertain the infection percentage.

Rust (*P. helianthi*) was exceedingly common (75%) during September.

Apple.—Brown rot (*S. cinerea*) was noted from many sources on Yellow Transparent and Montreal apples.

Black rot (*Physalospora cydoniæ*), while not common, was frequently found.

There was a heavy scab infection (*V. inæqualis*) wherever spraying was not done or where orchards were poorly sprayed.

Two interesting diseases were noted:—Phyllosticta leaf-spot (probably *P. solitaria*) in one orchard to the extent of 100%. and Bitter rot (*G. rufomaculans*) in two orchards on Fameuse apples but only to a slight extent.

Plums.—Wild plums were heavily infected by *Exoascus pruni* causing "bladder plums" but cultivated varieties were not affected. On the other hand the latter suffered from brown rot (*S. cinerea*) to the extent of about 1%.

A "wither-tip" the etiology of which at present is not known was sent in from New Brunswick.

Raspberry.—Mosaic and Leaf curl were still present, the season being such that the former was especially noticeable. In this district the Columbia variety must be added to the susceptible list.

Grape.—Grape mildew (*P. viticola*) was common this year on leaves, tendrils, shoots and fruit.

Elm.—On most American elms in Eastern Quebec there was approximately 30% infection with *Dothidella ulmi* causing leaf spot.

Butternut.—*Gnomonia veneta*, causing leafspot, defoliated practically all the butternut trees at least a month earlier than normal.

Iris.—Rhizome-rot caused by *B. carotovorus* was prevalent wherever this ornamental plant was grown. There appeared to be little doubt that injury to the rhizome during spring cultivation opened infection courts in the plants.

Sweet pea.—Mosaic was noticeable in many plots but was not so common this year as "stigmonose" and leafcurl caused by aphids.

Streak (*B. lathyri*) occurred frequently, especially during September.

Peony.—Leaf and stem spot caused by *Septoria pæoniæ* var. *berolinensis* was very pronounced.

Botrytis blight was present but not serious.

During the later summer an Alternaria leafspot a Phyllosticta spot and Cladosporium blight became common.

In one large nursery the roots of newly planted peonies blackened and died. They were like india-rubber in texture. The trouble appears to be due to a species of Fusarium.

Contribution No. 15, Dept. of Botany, Macdonald College, Que.

THE SEED PLOT AS A MEASURE OF PROTECTION.

By Omer Caron, Botaniste, Quebec Dept. of Agriculture.

The technical expert can in many cases control diseases by carrying out certain technical measures, but in the field the efforts of growers to do this are often nullified by causes beyond his control.

When one considers the practical aspects of plant protection, it is found that some are difficult to follow because of the cost of labour and the amount

of time required. It is important therefore to popularize natural methods of combatting parasitic fungi. As a result of many inspections, demonstrations, and complaints from one end of Quebec to the other, I have decided to urge the use of isolated seed plots.

In selecting seed, improving present varieties and creating and conserving new types, investigators confine their attention especially to individual plants. The idea now suggested is to use this method in a modified form by growing seed at home in carefully tended plots. This should not give one the impression of an experimental farm with its chequer board of experimental plots. It merely means that each farmer should set aside a small plot of land, or two or three small plots, isolated from the crop fields. In these plots he will try to grow clean seed or tubers for his own farm. Such efforts are especially desirable in the case of loose smut of wheat and in potato diseases.

Concerning loose smut of wheat, we say to farmers "Treat your grain by the hot water method", but it is much more difficult to do than to recommend. Many intelligent men have been disappointed at the results obtained. If a farmer does not succeed the first time he usually renounces the project—a result which is deplorable. The disinfection of large quantities of wheat against loose smut is impossible because the farmer is not equipped as a chemist and physicist. I realize that my remarks will probably engender the criticism that I am retrogressive, but put yourself in the place of the farmer and you will see better my point of view.

We tell them to buy good seed. At present it is almost impossible to obtain wheat free from smut and potatoes free from Mosaic or Leafcurl. The guarantee certificates are only valuable if the producer is honest. The fact that farmers in some localities are obliged to purchase seed in large quantities, facilitates the inclusion by the dishonest seller of second and even third rate seed tubers.

If we think of the continued spraying with all the necessary equipment, and of the initial disinfection, it is not surprising that many growers are irritated and do not carry out these precautions. Often the sprayings come at times when work is multiplied, during haying, hoeing, harvesting or when it is necessary to use men and horses on municipal work to reduce taxes somewhat. Those who have only a small acreage can manage, but it is the larger producers who often cease to practise control measures. I am not excusing him, but I am explaining the reasons which in many cases account for his action. Nevertheless what is not practicable on a large scale can be done in a small way in the isolated seed plot. To spot plants with wheat smut or potato mosaic is not easy on a very large field, but it can be done fairly easily in a plot of a few hundred square feet in area.

To determine the size of the seed plot it is necessary to know the amount of seed required the next year. For example if the requirement is fifty bushels then a plot giving about one hundred or more bushels. It is necessary to rogue diseased plants, cull diseased tubers at harvest time and make a rigorous selection in spring at seeding.. All these will reduce the available supply to about the amount required.

The use of such a seed plot should not do away with the necessity of spraying, but it would help.

Aside from the selection from a disease point of view, there is much to be gained in selecting for quality, purity of variety and yield. Such increase in quality and yield would more than pay for all the trouble expended.

The best cultural methods would have to be practised. A seed plot is a "spoilt child" in the bringing along of which one has to exercise all the supervision and protection possible. Roguing cannot be too severe and the plot should be changed and a long rotation practised to prevent the introduction of any disease.

I firmly believe that such methods would improve the crops in Quebec, I believe them to be possible of realization and think we should unite to urge the use of isolated seed plots.

THE RELATION OF INSECTS TO VEGETABLE SEED PRODUCTION.

R. C. Treherne, Entomological Branch, Dept. of Agriculture Ottawa.

When the question of pollination of plants is under discussion statements are usually based upon the conclusion that, generally, cross fertilization is beneficial to the species. It is usual to refer extensively to the value of insects in the act of cross pollination. A great deal has been written upon this subject and we have no doubts upon the matter that insects are essential to the satisfactory setting of fruits and seeds. In orchard work it is claimed that fully 99% of the cross fertilization is effected by insects and the same is very largely true with small fruits. It is only necessary to draw attention to the perfect and imperfect flowers of strawberry to appreciate the importance of this subject. It is, however, not my intention to enlarge upon this question at this time. Examples are available to every student, and nearly every practical horticulturist if he does not know the actual circumstances surrounding the crossing of plants at least appreciates the importance of plant and insect interdependence.

Today it occurred to me that a few remarks on the practical issues bearing upon the natural function of insects to the pollination of plants might not be out of place. The few remarks that I have to make refer to the question of seed production among vegetable crops. The notes that I have on this subject have been made up from some observations taken in British Columbia in 1918 while working on certain aspects of vegetable seed production—a project which received considerable impetus in that province about that time as a war measure. Just previous to 1918 the importance of producing home grown vegetable seeds became of consequence on the western coast. It was realized that the climatic and soil conditions were favorable to the production of vegetable seeds. A number of men were instrumental in placing this agricultural proposition before the farmers of the province. Mr. P. A. Boving, Professor of Agronomy at the University of British Columbia, Mr. Lionel Stevenson, at that time Superintendent of the Dominion Experimental Farm at Sydney, Mr. A. McMeans, Pacific Coast Representative of the Dominion Seed Branch, Mr. W. T. Hunter, of the Provincial Horticultural Staff, and Mr. L. E. Taylor, a practical fruit grower who became president of the B. C. Seed Growers Association, are all on record as favoring this industry. The prices to be received for home grown seed were favorable, while the prices to be paid for imported seeds were unfavourable, to say nothing of the dissatisfaction resulting from poor seed that was being used to some extent by the farmers of the province. With true western optimism a certain romance developed upon the possibility of developing a new agricultural industry and great endeavors took place at the time. While the leaders in the movement were fully aware of the difficulties and dangers of the situation based on the question of applied genetics, a surprising ignorance was shown by the average farmer in the matter of producing home grown seed. To many, all that appeared necessary was to select sound roots or plants such as cabbage, carrot, radish or onion, set them out in the spring and let them throw up seed heads from which a bountiful harvest of seed would be taken in the autumn. A good income of course would be expected. It was very interesting indeed to see some of these farmers' plantations in the year of 1918. Cabbages, turnips, swedes, beets, radishes, onion etc., were growing in great profusion, or, it might be better said, in great confusion, in rows, side by side, adjoining the farmers' outbuildings. Different varieties of these plants were to be found not only in a single acre but on neighboring farms, possibly in some cases only a few hundred yards away. All of this was essentially wrong and it was not surprising to find that when the growers experienced difficulties in the matter of seed registration their enthusiasm died down for the industry as a whole. Today I believe the same enthusiasm does not exist but as a result of the campaign that was conducted it was clearly shown that good seed could be produced, possessing high fertility and good germination. Soil and climatic factors were likewise favorable and it may be

truly said that if proper scientific study was given the question of vegetable seed production it could become a major agricultural industry. I presume that what applies to British Columbia in this connection might also apply to other areas in Canada. During the course of the campaign it became necessary to study insects that were visiting the vegetable seed heads to determine what insects were mainly instrumental in the carrying of pollen and how great a factor each respective insect was in this connection as a pollen carrier, and what were the distances of flight of the strongest fliers.

I have no intention of dealing with the pure plant breeder's point of view at this time, for the reason that my knowledge on the subject is too incomplete. It would not, however, be out of place to just briefly mention one or two fundamental ideas which bear upon the question of the insect's relation to seed production. In the first place I believe it is generally recognized that close botanical relations should not be planted together or in close proximity to each other. This applies just as much to plants of the same kind as it does to its varieties, in view of the fact that it is impossible to produce pure strains if more than one kind is in flower at the same time in the same immediate neighborhood. Mangels, for instance, do not unite with turnips, carrots, onions or parsnips but they will cross very readily with sugar mangels, garden beets and chard.

We accept the fact that floral parts are usually adapted for cross fertilization and the resulting progeny is stronger and more virile as the result of cross fertilization, but if cross fertilization fails self fertilization may occur. I believe it is usually considered that the seed yield is commonly decreased as the result of self fertilization. The common cabbage (*Brassica oleracea*) has been shown, for example, to be capable of producing a great quantity of seed capsules under either enclosed or open conditions but the actual quantity of seed produced is much greater in the latter case than in the former. Pollen prepotency, dominant and recessive characters, and such like questions are familiar subjects to the plant breeder. They account for decreased yields of seed and for the suppression or appearance of characters present in the parents. A field of French breakfast radishes will set a greater amount of seed if uninterrupted cross pollination is permitted. If a large number of other kinds of radishes, such as the White Icicle, are grown in the same field or in adjoining plantations the yield would not only depreciate but a great instability of characters would become apparent in the progeny. The same applies to mixed fields of drum-head and ball-head cabbages or any other crop where mixed varieties are planted. It is quite clear that should one engage in the production and sale of agricultural seed a good working knowledge of plant relationships and genetics is not only important but actually necessary. We are only concerned at this time, however, with the insect visitors to vegetable seed heads and it is on this subject that we will confine our remarks.

The study as we undertook it was really quite simple in as much as we only followed the idea of watching the plants closely for considerable periods at a time and noting the various insects which alighted upon the seed heads of the various crops. The specimens were also collected for later determination and percentages from captured material as well as from observational matter were built up. In the majority of cases the insects taken were examined under binoculars to determine whether or not pollen grains were adhering to their bodies. An endeavor was made also to conduct this work over a period of two or three months which meant that a certain number of days at periodic intervals were set apart for close observation while, on other days, only cursory observations were made. You will agree, of course, that this method was very haphazard but as it turned out we obtained the practical information which we were after. As you will see by the records that I propose to give you in a moment or two that the honey bee entered into the situation in every case and as the honey bee is not only the most diligent collector of pollen and nectar but also the strongest flier it practically eliminated all other insect visitors.

Mangels.

It has been stated by some authorities that the flowers of the field mangel is not visited by honey bees. This we can say is not correct. We must remember that the question of the available honey flow in a given district bears upon the point as to what insects visit flower heads of any particular kind. I do not doubt for a moment that if the country at any particular time of year is well supplied with flowering plants the honey bee would not be a factor in the pollination of mangels, but if the flow is light there is no question at all but that the honey bee will visit mangel heads. Over a period of two months the following average of insect visitors was determined.

Syrphids	64%
Solitary bees	17%
Hemiptera	8%
Honey bees	7%
Coleoptera	2%
Wasps	2%

We will have more to say upon the actual habits of these various insect in a moment or so.

Wind is a factor that must be considered in the carrying of mangel pollen just in the same way as wind is probably a prime factor in the carrying of corn pollen. Quite apart, therefore, from the question of insect visitors a proper regard must be taken of the question of prevailing winds when setting out fields of mangels for seed production. The flowers are small but they have

a remarkably sweet smell which apparently proves a strong attraction to syrphid flies. The honey bee you will notice, while an important factor is not a very great one with mangels. This would imply that mangels of different varieties could be planted closer together than many other plants such as, for instance, onions. With onions the honey bee over two months of July and August proved the greatest factor of all, as the following table will show.

JULY		AUGUST	
Honey bees	56%	Honey bees	80%
Solitary bees	24%	Fossorial Wasps	11%
Syrphids	13%	Solitary bees	7%
Bumble bees	6%	Syrphids	2%
Coleoptera	1%	Bumble bees	1%

Here we find that honey bees at all times greatly exceeded all other insects in numbers and activities. The onion produces flowers in great numbers upon a large compact, globular head. These flowers are largely self fertile, and strictly the honey bee is not an absolute requisite to the plant. The strong odor, however, must prove a great attraction. Unfortunately in this connection as with others in which note is taken of honey bees, I have no way of dealing accurately with the question of the desirable distances at which plantations should be separated. The apiculturists claim that when the honey flow is light honey bees will travel five miles for pasture. I do not imagine in a practical commercial way that it would be necessary to set onion plantations of different varieties five miles apart to ensure a pure strain of seed, although the danger of cross pollination might be present. We would doubtless not be far wide of the mark to estimate that a seed district of 2½ miles is sufficient to devote to the production of one kind of onion seed.

Carrots.

With carrots the following analysis was obtained which brings to our attention the importance of the honey bee at two different periods of the year. During July Coccinellids appeared in great number on the seed heads and honey bees were entirely absent; while in August the honey bee became the most important factor.

JULY		AUGUST	
Coccinellids	46%	Honey bees	26%
Hemiptera	19%	Syrphids	18%
Solitary bees	20%	Coccinellids	21%
Syrphids	7%	Solitary wapss	12%
Bumble bees	4%	Solitary bees	9%
Bombyliids	3%	Diptera (small)	9%
Tachinids	1%	Bumble bees	5%

In this case the activities of the Lady Bird beetles may be considered purely local and during the early part of the blooming period of carrots probably the solitary bees rank highest in importance, both from the standpoint of their habits and their strength of flight. Bumble bees while their percentage of prevalence was low, were very industrious throughout most of the season and, with the solitary bees, doubtless are the factors of most importance in the carrot seed area. I am informed from the writings of Prof. Boving and also from our general information on the subject that the different varieties of carrot cross readily among themselves and with the wild carrot, *Daucus carota*, the cross I believe resulting in a deterioration not only in color and shape but also in quality. The influence of the wild carrot is worthy of much consideration and attention must be given to the distribution of these wild plants in a carrot seed producing area. Their blossoming period coincides with that of the cultivated plants and extends over a greater part of the summer.

Sugar Beets.

With sugar beets we find that the Lady Bird beetles are again an important local factor, but solitary and social bees are probably the most important. As has already been pointed out the sugar beet is allied to the various mangel varieties and chard, and as the wind factor again enters the question, the same remarks as we made for mangels apply to sugar beets. The analysis over two months is as follows:

Coccinellids	32%
Syrphids	21%
Honey bees	20%
Solitary bees	14%
Hemiptera	13%

I have no records dealing with the insect visitors to swedes but, should this crop be grown for seed, we must not forget that swede varieties will not only intercross among themselves but they will mingle with turnips, rape and *Brassica campestris*. Prof. Boving has recorded an instance in Richmond County, P. Q., in 1915, where an examination of a field of swedes showed that the seed must have been very impure as the result of an examination that he made at that time. Fully 10% of the swedes showed excessively elongated necks, and at least 50% of the roots bore evidence of crossing in the abundance of prongs and crossing-lumps. In this instance the cross had been affected between swedes and *B. campestris* (Bird rape).

RADISHES

Mirids	34%
Diptera (small)	33%
Honey bee	22%
Coccinellids	5%
Bumble bees	4%
Asilids	1%
Pentatomids	1%

Parsnips.

With parsnips curiously enough the solitary bees prove the most important factor. Many of the species found were of large size and possessed considerable powers of flight. It is interesting to note in the analysis the attraction that parsnip flowers have for many insects which were not present in other seed heads.

Solitary bees	53%
Honey bees	13%
Mordellid beetles	10%
Solitary wasps	9%
Hemiptera	7%
Diptera (small)	6%
Syrphids, Cocccinellids, Cerambycids	2%

I regret to say that I have no record on cabbages but I am sure that we may feel quite safe in assuming that the honey bee again is a factor in cross pollination of cabbage varieties.

Sufficient has been said, however, to show that plants of different varieties belonging to the same kind should not be planted close together or in the immediate neighborhood. I believe that it is usually considered essen tial that when commercial seed production is engaged in special seed districts must be formed. All that we have demonstrated as the result of the study of insect visitors to these plants is that the honey bee is a factor in each case and this being a fact these seed districts must be of sufficient size to obviate the danger of cross pollination. It would doubtless be necessary to create legislation establishing seed areas in which certain varieties only are planted and in which an earnest campaign for the destruction of allied weeds is undertaken. In every instance with the insects mentioned in this paper, pollen grains were found on the bodies. Syrphid flies were numerous and, as you doubtless know, are clothed with long dense hairs which are usually simple though frequently curved at the tip.. These hairs form an excellent trap for pollen grains. Some species such as *Eristalis tenax* have compound branching hairs. Their movements on the wing and on the flowers are erratic standing while on the wing over selected blossons before settling. Many members of this group are strong and active in flight and doubtless cover considerable distances, but their method of blossom visitation is not systematic enough to cause them to be of great concern to plant breeders. Adults may be seen frequently freely visiting plant after plant in a single stand but have been observed to visit, just as freely, plants in bloom of different botanical families in the immediate neighborhood. They do not hesitate after visiting the blossom of a plant to settle on the leaves of neighboring plants which excrete sweet exudations. Currant leaves appear to prove a strong attraction and

they may be frequently seen passing backwards and forwards from a vegetable seed plantation to the leaves of neighboring currant bushes. Many of the species noted, furthermore, were aphidaphagous,—their larvae living among the colonies of aphids—and adults passed quite readily from the blossoms of plants to colonies of aphids on the twigs of apple or on the leaves of cabbages.

The food of Syrphids consists primarily of pollen grains, although they seek nectar to a considerable extent. The Muscids, likewise, seek nectar and pollen and the vestiture of these flies is sufficiently long and dense to permit the ready carrying of pollen grains. However, it is my belief that pollination is more usually affected through the mouth parts. Their habits of blossom visitation are like the Syrphid flies—somewhat spasmodic. Soldier flies or the *Stratiomyiidæ* are strictly flowerloving insects and many species may be taken on the blossoms of vegetables. The size of individual species varies considerably as do their powers of flight. They are probably of more importance than the two families already mentioned as plant pollinators. The Bee flies or *Bombyliidæ* are usually heavily clothed with a vestiture similar to that of bumble bees. Their hairs are long and rigid and project straight out from the body. Their mouth parts, however, are extended and this fact does not force them to burrow deeply into the blossoms in order to obtain nectar. They are erratic on flight and frequently dart considerable distances; their habits are most interesting. It is not unusual to see them hover over a blossom and after extracting the food they require, dart perhaps ten or fifteen or more yards before they visit the next flower. Pollination with these insects is doubtless purely accidental but their remarkable habits in flight doubtless place them in the forefront of local pollinating agencies. The Sarcophagids Dexiids and Tachinids are also of importance as pollen carriers but their influence is purely local and other flies such as Therevids, Dolichopodids, Anthomyiids, Ortalids and Conopids are not great factors. Their legs and bodies are not heavily clothed with hairs and while they may carry pollen, their influence is practically negligible. Among the Hymenoptera the honey bee, the bumble bee, solitary bees and wasps rank very high.

It will not be necessary to detail the structure of these insects demonstrating their effectiveness as pollen carriers. That subject has been dealt with extensively on many occasions. Among beetles we find many species that feed on pollen. They do not move rapidly from plant to plant except possibly in the case of the Cerambycids. Usually beetles found in the seed heads will remain on the same head for hours on end and naturally are considerable factors in the carrying of pollen from blossom to blossom in closely compacted seed heads. The roughened portions of their body, the small projections, the minute hairs, enable pollen to be transferred form place to place. With these few remarks I will close the subject.

There is perhaps one other thought that might be dealt with and that relates to the economic control of insects affecting vegetable crops in general. The work of the entomologist has developed certain recognized control operations which in the majority of cases are proving satisfactory and economical. One must always bear in mind, however, that the control of vegetable insect pests has to be cheap enough to be brought within the economics of crop production. This is not always possible. I think it would be no harm to draw attention to that aspect of insect control which has to do with the improvement of vegetable strains. A sound healthy plant growing from a sound healthy seed is better able to produce economic commercial returns than a plant growing from poor seeds low in vitality. For instance, in a field of turnips being grown for cattle feed the treatment of such a field with mercury bichloride would probably cost more than the plants were worth and in the majority of cases it would not be practicable to pursue control measures with insecticides. As the result of some practical experience in this very connection which I had once in a dairy section in the Lower Fraser Valley of B. C., it was found that the degree of seeding obviated the danger of severe attack by the cabbage root maggot. With plants which germinated at the rate of between fifty and seventy to the linear foot of row, the degree of injury was not as great as when the young seedlings appeared at the rate of between twenty and thirty. The larvae of the cabbage root maggot as you doubtless are aware, move to some extent along the row attacking plants as they go. However, such larvae do not leave the plants until they have exhausted practically all available plant food. This period of migration which, of course, coincides with the period of spring oviposition, take place previous to the time of thinning the crop and the period of thinning usually coincides with the termination of the spring oviposition period. Hence the thinning operations leave the sound plants intact. If, therefore, turnip seed shows a high percentage of germination it is natural that the quality of seed bears very closely upon the economic control of the cabbage root maggot in field turnips. Exactly the same line of thought might be pursued with onions, where with heavy seeding followed by thinning good strong healthy plants obviate or outgrow the spring attack of the onion maggot.

The weight of heads and roots bears a close relationship to the strength of the seed and it is this point that I would refer to as it bears directly upon this question of plant pollination. There is no reason in the world why we should not develop our own home-grown seed industry. Usually such seeds are stronger when grown locally. They are suited to their environment and if we can guarantee their purity the resulting plants are obviously better and more worth growing. It is usually claimed, of course, that our costs of production for seed crops are too high to compete with Europeans. You are

perhaps better able to judge the truth of this than myself but I see no reason why efforts should not be made to bring into being an industry which would prove of great value to Canada where the soil and climatic factors in the majority of cases are essentially satisfactory.

The following list of representative Diptera is presented to record the types commonly met with.

Syrphidae.

Sphaerophoria cylindrica Say. off carrot, beet, parsnip, onion, Kelowna, Walhachin, Keremeos and Victoria, B. C.

Syritta pipiens Linn. off carrot, beet, onion, parsnip, Kelowna, Walhachin Summerland and Victoria, B. C.

Syrphus ribesii Linn. off carrot, beet, onion, Kelowna, Keremeos, Walhachin, and Victoria, B. C.

Syrphus (*Lasiopthicus*) *pyrastri* Linn. off carrot, onion, beet, Kelowna, Walhachin and Victoria B. C.

Syrphus americanus Wied, off beet, Victoria, B. C.

Syrphus opinator O. S. off mangel, beet, Victoria, B. C.

Helophilus chrysostomas Wied...off beet, Kelowna. B. C.

Helophilus latifrons Lw. off beet, Kelowna, B. C.

Eupeodes volucris O. S. off carrot, Walhachin, Victoria, B. C.

Tropidia quadrata Say off carrot, Kelowna, B. C.

Eristalis arbustorum Osborn off carrot, Walhachin B. C.

Eristalis occidentalis Will, off beet, Victoria, B. C.

Eristalis meigeni Wied. off carrot, onion, Kelowna, Walhachin, B. C.

Eristalis inornatus Lw. off carrot, parsnip, Kelowan, Victoria, B. C.

Eristalis tenax Linn. off carrot, parsnip, beet, Victoria, B. C., Walhachin, B. C.

Paragus bicolor Fabr. off carrot Walhachin, B C

Pipiza pisticoides Will. off carrot, Walhachin, B. C.

Merodon equestris Fabr. off beet, Victoria, B. C.

Thevidae.

Psilocephala laevigata Lw. off carrot, Walhachin, B. C.

Dolichopodidae.

Psilopus pilicornis Ald. Kelowna, off carrot.

Bombyliidae.

Systoechus oreas O. S. off radish, Kelowna, B. C.

Anthrax lateralis Say. off carrot, Walhachin, B. C.

Anthrax hypomelas Macq. off carrot, Walhachin, B. C.

Tachinidae.

Phorantha occidentis Walk. off onion, carrot, Walhachin, B. C.

Senotainia trilineata V. d W. off carrot, Walhachin, B. C.

Senotainia rubriventris Mcq. off carrot, Walhachin, B. C.

Ocyptera dosiades Walk. off carrot, Kelowna, B. C.

Tachinamella Walk. off carrot, Walhachin, B. C.

Plagia americana W. off carrot, Walhachin, B. C.

Echinomyia algens Wied. off carrot, Victoria, B. C.

Dexiidae.

Myiocera cremides Walk. off onion, Walhachin, B. C.

Sarcophagidae.

Sarcophaga helicis Tns. off carrot, Kelowna, B. C.

Sarcophaga hunteri Hhg, off carrot, Walhachin, B. C.

Sarcophaga communis Park. off carrot, Walhachin, B. C.

Sarcophaga planifrons Ald. off carrot, Walhachin, B. C.

Sarcophaga pallinervis Thom. off beet, Walhachin, B. C.

Wohlfahrtia meigenii Sch. off carrot, onion, Walhachin, B. C.

Muscidae.

Morellia micans Macq. off carrot, Kelowna, B. C.

Pollenia rudis Fabr. off carrot, beet, Walhachin, B.C.

Musca domestica L. off carrot. Walhachin, B. C.

Anthomyiidae.

Limnophora narona Walk. off carrot, Walhachin, B. C.

Pegomyia ruficeps St. off carrot, Walhachin, B. C.

Phorbia cilicrura Rdi. off beet, carrot, Kelowna, Walhachin, B. C.

Ortalidae.

Tetanops aldrichi Hend, off carrot, Walhachin, B. C.

Anacampta latiuscula W. off beet, Vernon.

Conopidae.

Zodion fulvifrons Say. off carrot, Walhachin, B. C.

Occemyia loraria W. off carrot, Walhachin, B. C.

Stratiomyidae.

Nemotelus arator Mel. off çarrot, Walhachin, B. C.

Macrosargus viridis Say. off beet, Kelowna, B. C.

Stratiomyia norma Wd. off beet, Kelowna, Bl C.

—	Mangels %	Onions %		Carrots %		Sugar beets %	Radish %	Parsnips %
		July 13	August 2	July 7	August 18			
Syrphids.....	64					21		
Solitary bees.	17	24	7	20	9	14		53
Hemiptera...	8			19		13	35	7
Honey bees..	7	56	80		26	20	22	13
Coleoptera...	2	1						
Wasps.......	2		11		12			9
Bumble Bees.		6	1	4	5		4	
Coccinellids...				46	21	32	5	10
Bombyliids...				3				
Tachinids....				1				
Small Diptera.					9		33	6
Asilids.......							1	
Cerambycids.								2

A STUDY IN DISEASE SUSCEPTIBILITY.

Dr. B. T. Dickson, Macdonald College, Que.

The photograph in Plate 1 was taken in the experimental greenhouses of Macdonald College on February 10th, 1923. The plants in the bed were being used in a study of tobacco mosaic and all but two were inoculated successfully in October, 1922, with mosaic. The usual symptoms appeared as the plants developed until November 27th, 1922. On that day numerous small spots appeared in several lower leaves of mosaic-diseased plants. The spots were at first watersoaked, and about pin-head in size. They rapidly turned dark brown and eventually became almost white. In many instances zonation showed and on some leaves lesions coalesced between the larger veins. The disease spread as a result of the spraying and splashing of water from diseased leaves on other leaves of mosaic-diseased plants. In spite of continued attempts under ideal moisture conditions, no lesion appeared in any leaf of a healthy plant. It was at first thought to be wildfire from its symptoms but cultures gave only a micrococcus. Further study is being made of the disease, by T. G. Major, M.Sc., the Tobacco Pathologist of the Tobacco division Central Experimental Farm, Ottawa, in co-operation with the writer.

Several points of interest are to be noted in the photograph. The dwarfing of the mosaic-diseased plants is well shown. The two healthy plants are 2½ feet taller than the top of the photograph i. e they are twice as tall as, and with correspondingly larger leaves than, the diseased plants. Their unspotted condition is marked in the two lower leaves, showing among the diseased plants. The fact that healthy seedling are not affected is indicated in the two pot plants in the foreground. Mosaic symptoms can be seen in many of the leaves of affected plants.

The photograph is by Mr. H. R. Angell, a plant pathology student of Macdonald College.

Contribution No 16, Dept. of Botany, Macdonald College, Que.

PLATE I

THE NATURAL CONTROL OF THE GREEN APPLE BUG

(Lygus communis var. novascotiensis Knight) by a New Species of Empusa

By Alan G. Dustan, Assistant Entomologist, Dominion Entomological Laboratory, Fredericton, N. B.

The study which forms the basis of this paper was commenced in the sume mer of 1920 in the Annapolis Valley, N. S. At the time the Green Apple Bug was doing an immense amount of damage to the orchards in that section-in fact in a great number of the orchards the crops was being entirely wiped out each year by the ravages of this pest. A great deal of work had already been done along the line of artificial control but up until that year no natural control studies had been made and it was with a view to finding out what natural enemies the Green Apple Bug had preying upon it, and in the hope of being able to increase the efficiency of these parasites, that this work was under taken.

In order that what follows may be more clearly understood, a brief summary of the life history of the insect host is given.

The Green Apple Bug, as the name implies, is a small, green, Hemipterous insect, belonging to the family Miridae, which feeds for the most part on the blos soms, foliage and fruit of the apple.

In the spring when the blossom buds are beginning to show pink, usually about the last week in May, the nymphs begin to emerge. They are very tiny in this stage and pale-yellow in color. From the first they are extremely active and are able to run about on the twigs at a surprisingly rapid rate. As soon as they leave the egg they hide inside the blossoms where they feed, sucking the juice out of the opening buds and causing them to drop in great numbers. The nymphs turn green in color and are extremely difficult to see due to their habit of hiding under the leaves and in the blossoms. They grow and develop very rapidly and about a month after hatching reach the adult stage, when they are able to fly for considerable distances. In average seasons the first adults appear about the first week in July.

Mating takes place soon after the winged stage is reached. The females begin to lay their eggs during the latter part of July and, in some cases, continue the process right through the following month. The eggs are laid principally on apple trees, being deposited in the cambium layer of the twigs, chiefly on Gravensteins, Golden Russets, Nonpareil and Ben Davis varieties. There is

but one generation a year in Nova Scotia, these eggs hatching the following season, as has been already indicated.

Natural Enemies

This study has now been carried over two entire seasons and all investigations have shown quite clearly that the Green Apple Bug is almost entirely free from the attack of predators and insect parasites. A few of the nymphs are captured by ants and spiders but their great agility seems to safeguard them pretty thoroughly from the attack of all predators. Egg parasites of all kinds are wholly lacking, as are insect parasites in the nymphal instars and as a result the nymphs reach the last stage of their development practically unchecked. If all of these were able to develop into adults and deposit eggs, an enormous increase would result; but a very important control in the form of a fungous disease causes a large mortality in the last nymphal and adult stages, thus bringing about a very material decraese in the number of the adults before oviposition takes place. This fungus, which has proved itself capable of developing equally well in dry or wet seasons, has been of inestimable value to the orchardists and is rapidly causing the Green Apple Bug to disappear from the Annapolis Valley.

Life History and Development of Empusa nov. sp.

This organism, which proves to be a new and undescribed species of Empusa, passes the winter in the resting spore stage. These spores are found in the form of a dense envelope adhering to, and partially surrounding, the abdomens of diseased adults, which lie hidden away under the loose bark scales on the upper limbs of apple trees.

In the spring about the time the Green Apple Bug nymphs emerge each resting spore gives rise to a minute germ tube which develops into a small conidiophore, bearing on its tip a tiny conidium. In the vicinity of Wolfville the period of germination extends over at least forty days, which should be representative of conditions throughout the Valley.

When fully formed, these tiny spores are shot out from under the bark and float around in the air currents until they come in contract with a newly emerged nymph. They then germinate and a germ tube grows into the body of the insect, either through one of the spiracles or else directly through the integument at a point where it is thin, possibly between the body segments or leg joints. Once inside the nymph, the fungus commences to grow, not in

the usual manner by means of hyphal threads, but by a peculiar budding process in which socalled hyphal bodies are produced. These hyphal bodies are comparatively large, irregular fragments of mycelium, which at first float around in the blood of the insect where they rapidly increase in size.

Strangely enough, the fungus does not penetrate the thorax, for even when fully mature it still confines itself wholly to the abdomen. Just how long it takes the fungus to develop has not been learned but gradually the abdominal tissues begin to disappear, due to the action of the disease, and the number of hyphal bodies become proportionately greater. This increase goes on until the abdomen commences to swell and when development has progressed somewhat further, the whole dorsum bursts open.

Before this takes place, however, a change occurs within the insect. The hyphal bodies, instead of growing in their customary manner by budding, each send out a very stout tube which grows rapidly upward toward the back, of the insect and develops into a large club-shaped conidiophore. Hundreds of these are produced in a single insect, so that when the dorsum ruptures a flat, continuous layer is exposed which is formed by the tips of these uprightly growing conidiophores. This layer is in turn covered by a layer of hyalin mucilaginous material, closely resembling protoplasm.

At this point in the development of the fungus the majority of the Green Apple Bugs have reached the adult stage, although a few are still in the last nymphal instar, and as a result, most of the dorsally ruptured insects are winged forms. Due to the fact that the fungus has confined itself to the abdomen, the thoracic muscles of the diseased insects are still quite capable of functioning. As a result, the dorsally ruptured insects are able to move about the foliage quite easily and it is not an uncommon sight to see a nymph or adult walking over the infested trees trailing behind it a ruptured and frightfully mutilated abdomen. This retained power of locomotion helps greatly in scattering the spores and spreading the disease more widely.

When mature, the conidia are shot off into the air, each being surrounded by a mass of mucilaginous material which no doubt serves the dual purpose of protecting the spores from drying as well as aiding them in sticking to any surface with which they come in contact. If they a light on an unfavorable situation, secondary conidia are produced which are smaller and more oval than the primary ones and are in turn shot off into the air.

If the conidia alight on an adult Green Apple Bug, germination takes place and a germ tube grows into the body of the insect in the manner described. Up to a certain point the development of the fungus in this stage is quite similar to that found in the nymphs in the early part of the season. Hyphal bodies appear and grow freely in the abdomen of the host though in no other part, increasing in size and number very rapidly.

Apparently hyphal bodies from adults infected later in the season are quite similar in size and shape to those found in the nymphs in the spring, for careful comparisons were made and no differences could be found.

Growth of the hyphal bodies goes on until the abdomen of the host becomes completely filled. But now, instead of conidiophores being formed, resting spores are produced. This is done in a rather remarkable way. Up to this time the hyphal bodies had been very irregular in shape, varying from rounded or oval forms through all gradations to the most bizarre structures, many of which had long protuberances, giving them more or less of an amoeboid form. At this stage, however, a change takes place; the hyphal bodies become less irregular and more rounded in form and the contained protoplasm grows denser and to a large extent loses its vacuoles. Each hyphal body gives rise to a stout germ tube which gradually increases in length and finally grows through the integuments of the insect. During this growth the contents of the old hyphal body migrates into the tube and follows the growing point so that when the fungus bursts through the integument, all the protoplasm is collected at the tip. This apical portion now begins to swell and soon a rounded, globose body forms into which all the contents of the tube flows. The walls of this structure gradually thicken and in this way the resting spores are formed outside the body of the insect, though really adhering quite closely to it. As far as can be learned, these spores are asexually formed and hence are azygospores.

About the time the hyphal bodies are commencing to lose their irregular form, the adults become very restless and wander over the tress in search of a place in which to hide. They soon crawl away out of sight under some loose piece of bark and there die very quickly. After the death of the host the fungus goes on developing until the resting spores are formed, by which means the disease is carried over the winter.

Artificial Spread.

As has already been stated, the main object of this study on the natural control of the Green Apple Bug was first to find out what parasites were attacking this insect and then to make every effort to increase their effectiveness.

With this end in view, a detailed study of this new Empusa was made both in the laboratory and the field, to see if it was not possible to make the disease more generally useful in checking outbreaks and to find out whether it was possible or not to spread it artificially into localities where it was not already present.

In the laboratory every effort was made to grow the fungus on artificia media but without results. Resting spores, primary and secondary conidia,

as well as hyphal bodies from both the conidial and resting spore stages were experimented with at different times and in a number of different media, but no success followed these efforts. Although this was not altogether a surprise, still, it was disappointing as it was hoped that it might be possible to grow conidia artificially and spray them on the insects in the field.

When it was found that such a method was impossible, a study of the disease was commenced in the field to see if the fungus could not be spread by transferring diseased insects in different stages from one orchard or from one locality to another. This work has been carried on over two summers and it can be said now quite safely that the fungus can be spread, and has been spread, artificially very successfully from orchard to orchard. It also seems quite probable that by the same methods it will be possible to transfer the fungus from one locality to another. This will be tried out next summer for the first time.

In regard to methods, it has been found that there are three ways in which the fungus may be spread. These will be taken up separately and described in more or less detail.

Methods No. 1: Undoubtedly the best method so far tested out is the one in which freshly-ruptured insects, which are actively discharging spores, are transferred from an infected orchard into one showing no signs of the disease. Several orchards have been treated in this way and good results have always followed. The conidia discharged from the introduced insects infect the adults with the result that an outbreak of the disease takes place and a large number of bugs crawl away under the bark where resting spores are produced. In the spring these germinate in the manner already described and the emerging nymphs are attacked by the fungus.

In carrying out this experiment care must be taken to gather the ruptured insects while fresh. This can be done to best advantage early in the morning when the dew is still on the tress. Also best results followed when the diseased forms were introduced into heavily infested orchards, for the heavier was the infestation, the faster did the epidemic spread.

Methods No. 2: In the late summer when all the Green Apple Bugs have reached the adult stage one often sees in orchards where the disease is present numbers of these insects scurrying around on the larger branches, apparently looking for a convenient place in which to hide. These are diseased forms in search of secluded spots where they may crawl away and die. If a number of such insects are captured while still alive and introducted into an orchard, they quickly find shelter underneath the bark of these trees. Here the resting spores are formed and in the spring primary infection of the young nymphs takes place through conidia arising from this source. As many diseased

adults as possible should be transferred at one time and best results have been obtained where they are all placed on one heavily infested tree situated in a central part of the orchard.

Methads No. 3: The third method of artificially introducing the disease into an orchard is practised in the spring before the blossoms unfold. This consists in transferring the resting spores from one orchard to another. The best way in which to do this is to gather the loose pieces of bark, under which the resting spores pass the winter and to which they closely adhere, and by means of tacks attach them to the upper limbs of the trees to be infected. Care should be taken to fasten the bark scales so as to have the surface on which the spores are born next to the tree and not directed away from it. As in the previous method a large number of spores must be transferred and they should be concentrated on one central tree in the orchard under treatment.

Economic Importance of the Fungus.

In Nova Scotia the Green Apple Bug is a comparatively new pest, having been noticed for the first time in June, 1914, but notwithstanding that fact it is now considered one of the worst, if not the worst, insect with which the orchardist has to contend. Speaking of the seriousness of this pest Dr. W. H. Brittain in his bulletin entitled "The Green Apple Bug in Nova Scotia" (Bull. No. 8, N. S. Dept. Agric.) says, "The apple crop in the Annapolis Valley has not been increasing at the rate one would expect from the new acreage constantly reaching bearing age each year. On the contrary, it seems to have, on the whole, actually gone back. There is little doubt in the mind of the writer that this condition of affairs can to a large extent be laid at the door of the Green Apple Bug."

Since the publication of the above-mentioned bulletin (1917) this insect has been gradually decreasing, not only in the sprayed orchards but just as rapidly in the untreated ones. At that time investigators working on the artificial control of the bug were at a loss to account for this strange and unprecedented numerical reduction. Since the discovery of the fungus in 1920, however, the problem has become clear, for it seems quite certain now that the disappearance of the Green Apple Bug was due wholly to the work of this fungal parasite. Studies carried on subsequent to the discovery of the disease have shown that the insect is still decreasing and that the decrease is being brought about by the Empusa in question, which goes to prove the truth of the above theory. With such an important natural control factor availeble and one amenable to artificial dissemination, it seems safe to predict that the Green Apple Bug will never again be as serious a pest in the Annapolis valley as it has been in the past.

PEONY DISEASES

by J. G. Coulson

The peony is one of the important economic ornamental plants and some growers have a good deal of capital invested in them. Very little has been written concerning the diseases of the peony and it is for the most part considered to be a sturdy perennial plant remarkably free from all such troubles, but a little observation any season will show that the different varieties are more or less subject to quite a number of diseases. The amount of infection undoubtedly will be found to vary a good deal, depending upon the season and other conditions, but during the last two summers that the diseases of this plant have been under observation at Macdonald College most varieties have shown severe infections. Last summer we received several inquiries concerning diseased conditions of peony plants and this with our own observations would lead us to believe that disease is quite general in Quebec and Ontario.

Saccardo lists 42 fungi found upon the peony. These may be grouped as follows:

On living leaves	18.
On living stems	5.
On leaving leaves and stems	2.
On fruits	1.
On underground parts	1.
On dying leaves	3.
On dead parts	12.

This gives a total of thirty fungi found upon living parts of the plant and we may conclude that at least the large majority are disease producing. There is no reason to believe that this list should include all the fungi which cause disease in the peony. Our work which was begun a year ago this fall (1921) at the suggestion of Dr. Dickson has shown the peony to be subject to at least seven different distinct diseases. These will now in turn be briefly described. The first two diseases have been known for a long time and will merely be mentioned.

1. Botrytis blight—(*Botrytis Pœoniœ Oud*).

This is generally considered to be the most trouble some and most common disease of the peony and is well known to everyone as producing "blasted" or brown and unexpanded buds, or large dead spots upon leaves and stems.

2. Cladosporium leaf blotch—(*Cladosporium Pœoniœ Pass.*)

This produces large blotches, purple above and chestnut-brown below, upon the leaves. Estimated infection for all varieties 5%.

3. Septorial leaf spot—(*Septoria pæoniæ West var. berolinensis Allesch.*)

This undoubtedly is a very troublesome disease of the peony, affecting both leaves and stems and was first noted at Macdonald College in Aug., 1920, The amount of infection upon the leaves ranged from 0 to 85% on different varieties, and the average for all varieties, was estimated at 20% for the fall of 1921 and 1922. Usually where heavy leaf infection occurred severe stem infection was also found. The spots on the leaves are small, limited by veins more or less round, yellowish-brown, with pale or ashen gray centres, purple bordered and usually showing zonation. The centre is usually somewhat sunken, shows a tendency to drop out and when this happens various Alternarias' are invariably found in the spots. On the stems the spots are whitish purple-bordered and tend to become elongated.

Last spring this disease was first observed upon the young stems of a few plants on the 10th of June, and was the first disease to make its appearance. From the stem it spreads to the leaves, first infecting the leaves toward the interior of the plant due to moist conditions prevailing there. This as well as other diseases spread very rapidly during the rest of June, and the first half of July during which period there was a good deal of rain. From this time very little new infection occurred until the middle of September following a period of considerable rain.

The spores are produced in brown gregarious pycnidia with a distinct ostiolum. They are described by Saccardo as being fusiform, curved, accuminate at both ends, indistinctly multinucleated, hyaline 25—30 = 1½—20.

Spores can be found in quite young lesions and in great numbers and it was quite easy to isolate the fungus in pure culture. This is the second time that this fungus has been reported for America, it being first reported by Anna E. Jenkins in Pathological Herbarium Notes issued by the United States Dept. of Agriculture, Bur. of Plant Industry. No. 2, Sept. 1st, 1921. This fungus has been isolated and infection experiments and further studies will be carried out this winter .

4. "Mosaic" disease.

This is found upon a few varieties, but cannot be considered to be a troublesome disease.

5. Two leaf spots of unknown cause.

(a) A disease characterized by irregular lead-white spots with a comparatively broad purple border. These spots are for the most part confined to the upper surfaces of the leaves and do not show or only slightly on the under surfaces. When showing through the under surface they appear as light brown spots. Scattered, black, more or less erumpent pycnidia or peritheria

can be found on many of these lesions. Examination has shown these fruiting structures to belong to Phyllosticta, Pleospora, Septoria, and possibly one or two other genera. An undetermined Phyllosticta is, however, most commonly associated with this disease. Various fungi have been isolated in pure cultures from these spots and inoculation experiments will be carried out.

This disease was first noticed on the 26th of July. It did not increase very rapidly and the amount of leaf infection this fall was estimated at 2%. See fig. I.

(b) Another leaf disease characterized by definitely limited irregular, yellow spots with a dark border in most cases was quite common on a few varieties. The spots vary from 2 to 8 mm. broad.

The fungus most consistantly associated with this disease is a species of Alternaria. This has been isolated and artificial inoculations were carried out last winter upon two plants in the green house and again last spring upon plants in the field. By keeping the plants under bell jars for two or three days after the inoculum was applied, it was quite easy to get infections and typical spots begin to develop in four or five days. The inoculum used was a suspension of spores in distilled water applied as a spray or a portion of agar from a test tube culture with mycelium and spores placed upon the leaves. From most of the lesions so produced the Alternaria was again isolated in pure culture. This is quite strong proof of the pathogenicity of this fungus. As only two plants were available last winter, it was impossible to have sufficient controls to work with and the field inoculations are not considered to be too reliable as the plants may have been inoculated from some other source. With more plants in the green house available this winter it is hoped that we will be able to thoroughly establish proof of the pathogenicity of this fungus.

6. Disease of the underground parts.

A plot of peonies at Senneville last summer was very heavily infected with a disease of the underground parts which was confined chiefly to the roots. The plants were set out last spring on land which had been used for some time as a garden.

The tops showed a marked wilting and dying with a blackening of the stem passing upward from the ground. A number of plants produced new branches and leaves in the late summer or fall. The roots on plants in which the tops were dying or dead were themselves dead or dying. The entire underground portion was usually blackened to a considerable extent. It is believed to be a Fusarium root rot as growth of Fusarium could be found on most of the roots and this was isolated in pure culture.

Summary.

Peony plants in this district are subject to at least seven distinct diseases. The most troublesome disease being the Septorial leaf spot.

Contribution No. 17, Dept. of Botany, Macdonald College, Que.

Plate II.

Fig. 1.—This shows lesions believed to be caused by an undetermined *Phyllosticta*. The spot at A is very typical. The others are somewhat larger and more irregular than usual. The spots developed in the field after a moist period o some days and this perhaps accounts for their large size.

Fig. 2.—A close up view of the Septoria spots included in the outlined area in Fig. 3.

Plate III.

Fig. 3.—A leaf infected with *Septoria paeoniae var berolinensis.*

Fig. 4.—A plant with a disease of underground parts and lower part of stem.

Fig. 5.—The same plant after it had been kept under a bell jar for some time showing the stem overgrown with a Fusarium.

Fig. 6.—Septoria spots on stem.

COMBINATIONS OF DUSTING AND SPRAYING MATERIALS.

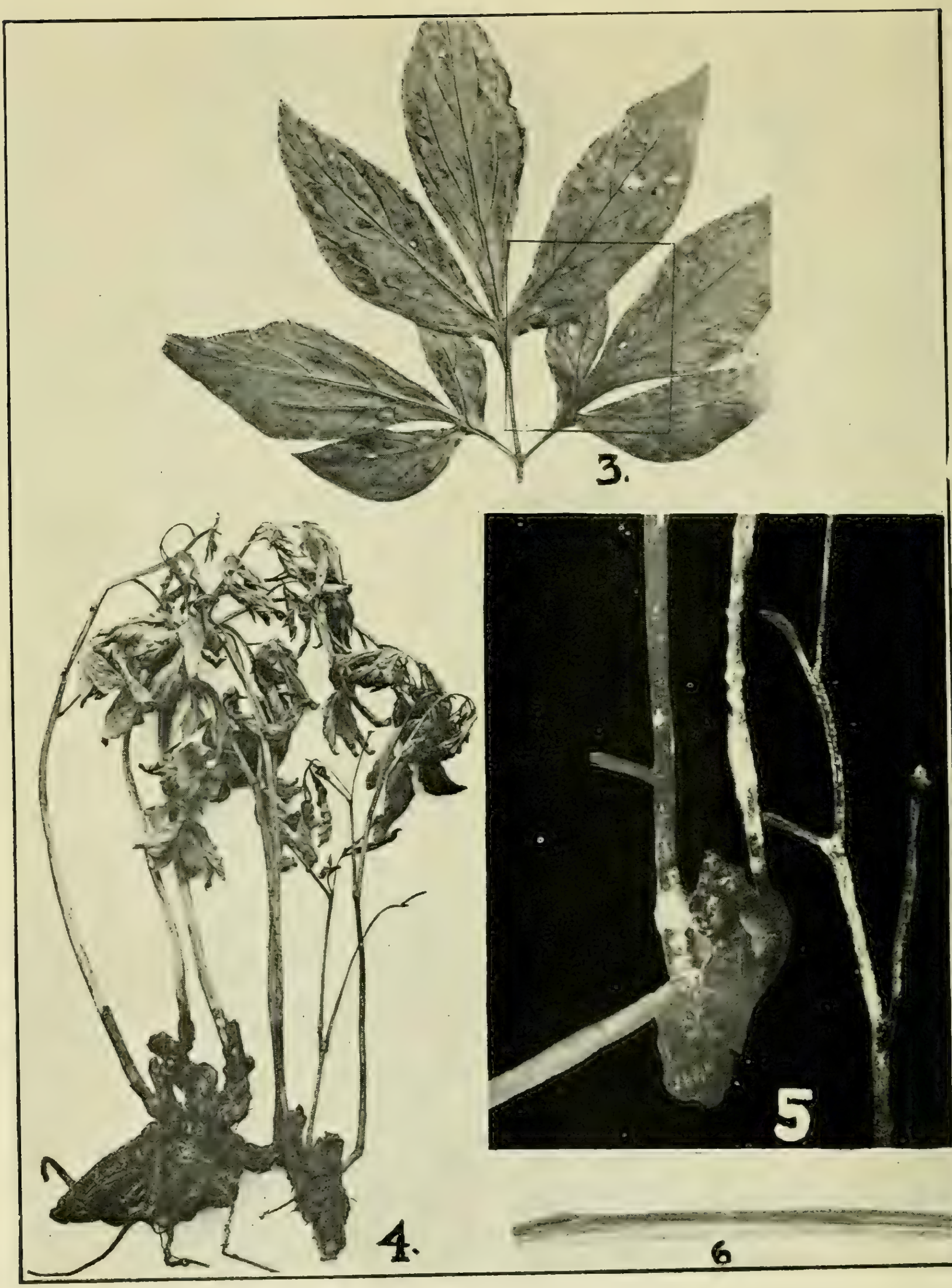
by

George E. Sanders.

The reactions that take place between the various chemicals used in dusting and spraying are not as yet as thoroughly understood as they should be. In the short space allotted it is impossible to give more than a brief sketch of each beneficial or injurious reaction that has come to my notice and to outline a few of the desirable and undesirable combinations.

Copper Compounds.

One of the best known reactions is that of lime on copper sulphate in the making of Bordeaux. When just enough lime is added to a copper sulphate solution to neutralize it, we get a precipitate of basic copper sulphate. As more lime is added we get a series of double copper calcium sulphates, each more basic than the last. When around five parts of lime to one of copper


3.
4.
5
6

sulphate is added, we get copper hydrates formed. The curious thing about this reaction is that even when equal parts of lime and copper sulphate are present there is a great excess of free lime and as more lime is added more of the lime combined chemically with the copper. This reaction is important in that potatoes will stand basic sulphates and double basic sulphates, while apples demand that a portion at least of the copper be in the hydrate form. Hence the recommendation of excess lime Bordeaux or 3—10—50 for apple spraying. It has been found that magnesium lime has greater neutralizing power, or makes a safer Bordeaux, than high calcium lime.

Copper sulphate for use on ground crops such as potatoes may be combined with a number of basic salts, such as magnesium oxide, magnesium hydroxide, sodium carbonate, sodium hydrate, sodium silicate, potassium carbonate, fish oil soap or even free nicotine.

Copper Combinations with Arsenic.

It is not generally recognized that copper is a safer and more reliable neutralizer for soluble arsenic than is lime. The copper of Bordeaux reduces the killing value of arsenicals used with it by around 43 per cent. Almost any arsenical can be used in Bordeaux mixtures if the proper precautions are taken in combining it.

The most commonly used poison in Aroostook County, Maine, is arsenate of soda, which is sold under the name of arsenoid. The arsenate of soda is dissolved in water and added to the completed Bordeaux. The majority of the arsenate combines with the lime to form arsenate of lime, but a portion at least combines either wholly or partially with the copper.

The old "Kedzie" formula, which results in an arsenite of soda solution, is an excellent Bordeaux poison, but when added to the completed Bordeaux it frequently gave some burning on account of too great a proportion. If the arsenite of soda is poured into the copper sulphate solution and caused to form green arsenite of copper before the lime is added that burning is almost entirely eliminated.

D. E. L. Mixture is 50 per cent superfine dust collector white arsenic and 50 percent hydrated lime. The lime causes the arsenic to wet readily and when in solution the two combines to form what we think is acid arsenite of lime. If copper sulphate is dissolved into water containing this mixture, green cooper arsenite is formed and the stock solution of copper sulphate containing the green precipitate of copper arsenite may then be used in the regular way and combined with the proper quantity of lime to make Bordeaux. This is by all odds the cheapest Bordeaux poison on the market and it has been used successfully for three years now in New Brunswick and Nova Scotia.

Arsenate of lead is very widely used in Bordeaux mixture, the theory being that it is more adhesive than other poisons. The lime and the copper in Bordeaux break away two-fifths of the arsenate from ordinary hydrogen arsenate of lead to form either calcium arsenate or double copper calcium arsenate. The remainder forms basic lead arsenate. Lead arsenate is a very slow killer in Bordeaux. The sticking value of arsenate of lead in a Bordeaux is so surpassed by the superior sticking value of the Bordeaux itself as to make the sticking value of the arsenate of lead negligible in the combination.

Paris Green is still the favorite in many sections of the country as a Bordeaux poison. After all the trouble that the manufacturer has in forming a nice green copper aceto arsenite crystal, the Bordeaux extracts the acetic acid to form either calcium acetate or copper acetate and leaves arsenite the same as we get from pouring arsenite of soda into a copper sulphate solution.

Arsenate of lime is probably the ideal poison for use in Bordeaux. It is low in cost, the copper acts very slightly on it, if at all, and it should give as good or better killing than any other arsenate in Bordeaux.

Lime Sulphur and Arsenicals.

Lead Arsenate is the most popular poison in lime sulphur solution. We all know that a reaction takes place between the two. Various competent chemists have explained this reaction to us in various ways. We know that there is a reaction. If we puddle our lead arsenate with calcium caseinate we reduce this reaction. If we puddle our lead arsenate with lime we do the same. We do not know if an excess of lime is desirable in lime sulphur since after a short time we have to depend on the $S0_2$ formed from precipitated sulphur as our fungicide, and we would expect the excess of lime to neutralize this $S0_2$ and so reduce our fungicidal value.

Some arsenate of lead which contain certain spreaders, stickers, and suspending agents, react much more completely with lime sulphur solution than straight lead arsenate. Recent knowledge regarding the manufacture of calcium arsenate helps to explain this reaction.

Arsenate of lime has been quite widely used in lime sulphur and I believe that the time is coming when we will all be recommending arsenate of lime in lime sulphur, but our present arsenates of lime vary too much for this recommendation to be made at the present time. The addition of a couple of pounds of high calcium lime for each pound of arsenate of lime in lime sulphur makes it safe, but we are there up against the danger of cutting down the fungicidal value of our lime sulphur.

Sodium Polysulphide Combinations with Arsenic.

Lead arsenate cannot be used in sodium polysulphide solutions. Arsenate of lime has been used successfully with sodium polysulphide in the following:

1 lb. sodium polysulphide.
¾ lb. arsenate of lime.
5 lbs. high calcium hydrated lime.
50 gallons. water.

Dusting Sulphur.

Dusting sulphur depends for its fungicidal value on the $SO2_2$ formed. Where the temperature gets very high, SO_2 may be formed so rapidly as to cause burning. Where the temperature is very low SO_2 may be formed too slowly to set as an efficient fungicide. This defect of sulphur dust often shows up in the control of apple scab which is a cool weather disease. The value of sulphur dust depends largely on the temperature and the uneven results following its use as compared with the more even results of copper are thus explained. In very hot climates, where there is danger of sulphur dust burning, the use of ten or fifteen per cent of lime is necessary. In cool climates the use of lime in sulphur dust is a detriment as it neutralizes the SO_2 as rapidly as it is formed and reduces the fungicidal value too much.

Sulphur Dust and Arsenicals.

Lead Arsenate is the standard poison for use in sulphur dust. Arsenate of lime is too cautic for use on foliage, even when diluted with sulphur. In spite of this, arsenate of lime is being successfully used with sulphur in certain localities.

Red arsenic, or realgar or arsenic tersulphide, is insoluble in acids and solu ble in alkalis. Red arsenic has been used with safety in pure dusting sulphur-but is too heavy and dense for a good dusting material.

Copper and Sulphur Cominations.

It has always been assumed that copper and sulphur neutralized each other completely. There is now some question as to the accuracy of this. How--ever, it is safe to say that the use of copper and sulphur mixed in dusting materials is undesirable and wasteful, although the status of copper sulphide and copper sulphite as fungicides is yet to be established.

Nicotine Combinations.

If we pour free nicotine into a copper sulphate solution we get a blue nicotine Bordeaux. Just what the status of copper nicotine sulphate is as a contact insecticide, I am not prepared to say, but I do know that such a compound is highly undesirable in a nicotine dust where the volatile nicotine only is of value.

The presence of dehydrated copper sulphate in a nicotine dust cuts down the volatility of the nicotine by about one-third. In the same way the presence of acid lead arsenate reduces the volatility of the nicotine. The presence of organic matter or the presence of moisture also retards the volatility of nicotine. The making of nicotine dusts is a very particular operation and for the greatest economy and efficiency only straight nicotine dusts should be used. "Three in One" and "All in One" dusts mixtures are inefficient, costly and undesirable.

Copper Arsenic Dusts.

Three types of copper dusts, in addition to the dried Bordeaux powder that has been offered for so many years, are now being offered.

Blue Copper Arsenic Dust.

This dust is made up of monohydrated copper sulphate, hydrated lime and arsenate of lime. It is called Blue dust on account of it turning blue when brought in contact with water. It is when applied merely a mechanical mixture of the three ingredients, combination taking place or Bordeaux salts being formed when the material comes in contact with moisture on the plant leaves. While this material is light and fluffy the active ingredients in it will only pass a 200—mesh screen.

The high limits of a 200-mesh, monohydrated copper sulphate in this type of dust are 35 per cent on the potato and 20 per cent on the apple. By using magnesium hydrated lime and getting the copper sulphate ground extra fine a higher percentage of copper sulphate be used with safety. In practice I do not find it advisable to go beyond 25 per cent of monohydrated copper sulphate for the potato and 15 per cent of monohydrated copper sulphate for the apple in this type of dust.

Lead arsenate has been used by us in this type of dust and is insisted upon by some experimenters. Lead arsenate increases the cost and does not seem to me any more desirable as compared with arsenate of lime than it is in liquid Bordeaux.

Superfine dust collector white arsenic was used by me in this type in my own orchard one season with no injury. Mr. Kelsall used it in his orchard with

the result that he got some leaf injury. There is just a possibility that white arsenic might be used in this type of dust on potatoes to good advantage. Extreme care would have to be taken in having the same white arsenic from the same source used every year, for white arsenic is one of our most variable products so far as its reactions go.

Brown Copper Arsenic Dusts.

This dust is made up of arsenic acid, crystal copper sulphate, burned lime and water. The heat of the slaking lime is utilized to convert the arsenic acid. into arsenate of lime and to cause the copper to be dehydrated and combined as double basic sulphates. This dust is being sold entirely for apple work this season in the proportions of 18 pounds of crystal copper sulphate, 8 pounds of arsenate of lime and the remainder, to make up 100 pounds, hydrated lime. This dust is not so easy to grind or so fine as the Green Copper Arsenic dust, which follows.

Green Copper Arsenic Dust.

This dust is the lowest priced of all dusting materials. It is made up of white arsenic, crystal copper sulphate, burned lime and water. As in the last, the heat of the slaking lime is utilized, but the arsenic is caused to combine with the copper, forming double copper calcium arsenite. This dust is made for the potato in the formula of 9 per cent metallic copper and 5 per cent metallic arsenic, or the equivalent of 36 per cent of crystal copper sulphate and killing value in arsenite form equal to 25 per cent of arsenate of lead. This dust is being sold for less money than the average farmer can purchase equivalent values in crystal copper sulphate, arsenate of lead and lime for making up liquid Bordeaux thus making dusting materials, for the first time, cheaper than equivalent, materials for liquid spraying.

The extreme friability of this type of dust makes it possible to pulverize it so that over 98 per cent will pass a screen of 325 meshes to the inch. The soluble arsenic in the 9-5 Green potato dust can be made 0.11 and the soluble arsenic in the 6-3 Green apple dust can be made 0.1 which is much lower than either crop demands for safety.

I have endeavored in this paper to give a brief resume only of the points that are now uppermost in combinations of copper, sulphur, arsenic and nicotine.

WHITE ARSENIC AS AN INSECTICIDE.

By G.E. Sanders.

In discussing the above it is difficult to say just where we shoud draw the line since practically all the arsenicals on the market today are made from white arsenic. In this paper I shall endeavor to confine myself to white arsenic itself and the materials or compounds that may be made from it by one single farm operation.

White arsenic is not by any means a standard article. It may vary in purity from 40 to 99 per cent pure. Even 99 per cent arsenic may contain enough impurities, which may be antimony, bismuth, lead, sodium, etc., to affect its behavior in most tantalizing ways. White arsenic as it is sublimed varies in fineness from around 100 mesh to an impalpable powder. In a smelter where 90 per cent of the output runs 99 per cent pure with a fineness of around 150 to 200 meshes, the remaining 10 per cent will run from 90 to 96 per cent pure and for the most part go through a 300-mesh screen. It is this extremely fine dust collector arsenic that is from 3 to 9 per cent low in purity that I have found best adapted for direct use as an insecticide.

One of the most remarkable and tantalizing things about white arsenic is the remarkable effects that even small quantities of impurities have on its reactions which prevent an experimenter from saying, "A certain purity of white arsenic if ground to a certain fineness will do this or that". What it may or may not do depends on the impurities present which may speed up the reaction as in the case of sodium or slow it down as in the case of bismuth.This is the big objection to the use of formulas that allow the farmer to utilize raw white arsenic. Briefly, there are three uses to which white arsenic has been put directly, vix:

1. Dusting directly on potato Vines.
2. In Baits.
3. In Bordeaux Mixture.

1. Dusting Directly on Potato Vines.

Experiments on this were conducted by Cooley in Montana. It was reported that white arsenic was used directly and straight on potato vines in Montana with safety. The only details that I got from Professor Cooley were that a particularly pure and fine grade of white arsenic was used. In a dry climate like Montana and where the hot, sunny summers make the potato leaves very tough and where there is probably less ammonia in the air than in most potato sections, we would expect this. In addition, Professor Cooley may have happened to use a white arsenic that was not only low in sodium and potassium, but which contained some such impurity as bismuth.

I have used various grades of white arsenic on potatoes in Nova Scotia and the burning there from 99 per cent pure material was usually moderate to bad, say from 10 to 30 per cent of the leaf area destroyed. With dust collector arsenic, much finer material and only 90 to 96 percent pure, the burning was invariable severe. The addition of lime, particularly magnesium lime, greatly increased the burning.

I do not think that we can ever recommend generally even the most pure white arsenic for use straight on potatoes. It may be that some particular grade from certain ores may find a place in the drier sections of the northwest, but there I am quite sure that the source, the purity and the methods of refining would have to be watched too carefully to make it of safe, wide application.

2. In Baits.

For cutworm and grasshopper baits, white arsenic is ideal. Some years ago, J. J. Davis reported excellent results from a low grade white arsenic from one of the Western U. S. Smelters. In 1921, I corroborated Davis' work, using dust collector arsenic of much greater fineness than Davis had used. I found that one pound of dust collector arsenic, running 92 percent pure and of a fineness of 250 to 300 meshes to the inch, possessed greater killing value on grasshoppers than an equal weight of 99 percent pure material having a fineness of around 200 meshes. The higher solubility of the dust collector arsenic on account of the impurities in it and its greater fineness were both factors in causing it to be superior pound for pound to the purer material. I found dust collector white arsenic superior to all other materials tested for grasshopper baits. It is, of course, lower in cost than pure white arsenic and infinitely cheaper than Paris green.

We found the best and most economical bait formula to be:

5 lbs. dust collector arsenic.
10 lbs. salt.
100 lbs. bran.
Water to make a mash.

We could get no benefit from banana oil, fruits, fruit extracts or any other attractants. The great attractant in the locality in which I was experimenting, Manitoba, was water. Farther west, where the water was alkaline, Mr. Kelsall carried on numerous experiments in 1921 and there he got no appreciable benefit from salt. In Manitoba, where the water was sweet, I got a decided benefit from salt.

Paris green is, of course, a good poison in baits, but it causes more poisoning than white arsenic among the men in the mixing stations and is much more expensive.

White arsenic, particularly dust collector white arsenic or any low grade white arsenic, if ground to sufficient fineness, is superior to all finished arsenicals and to pure or 99 per cent white arsenic for grasshopper and cut worm baits.

3. In Bordeaux Mixture.

In 1917, under instructions from the late Dr. Hewitt, we started investigating the possibility of using white arsenic directly in Bordeaux mixture. When added directly to Bordeaux, white arsenic showed two serious defects. First it would not wet readily. Second, a portion of it combined with the lime to form, a very soluble arsenite of lime with the result that leaf injury was caused. Mr. Kelsall was with me at the Annapolis Royal Laboratory at the time and as one of us would give the problem up in disgust, the other would pick it up, add something to it and then give it up again, until we finally got a fairly practical method of using white arsenic in Bordeaux and a large number of farmers in New Brunswick used it.

The steps as I remember them, were as follows:—One of us by accident mixed some dust collector arsenic with hydrated lime and found that it would wet through quite readily and quickly. Next, one of us noticed that Bordeaux into which we had mixed this white arsenic hydrated lime mixture was turning color from a blue to a green on the leaves of the plants.. About this time we were beginning to realize that copper sulphate was of very much more value than lime in eliminating soluble arsenic. Then a long series of tests in the chemical laboratory followed and Mr. Kelsall announced that a good factory product could be made by our method, but that it was not yet fit for the use of farmers. It was then dropped for almost a year and then we developed what has proved a practical farm method. We prefer to use dust collector white arsenic of around 90 to 95 percent purity on account of its greater solubility, fineness and the speed with which it reacts. We mix equal parts of hydrated lime and white arsenic together and mix them in the water into which we intend to dissolve our copper sulphate. Then we hang a bag of copper sulphate in the top of the water and let it dissolve, stirring occasionally. After the bluestone dissolves, use in exactly the same manner as ordinary copper sulphate solution in combining with lime to make a Bordeaux. Use about 1½ lbs of dust collector arsenic and 1½ lbs of lime in the copper sulphate solution intended for an acre of potatoes.

The reaction that we suppose takes place is the formation of a very soluble arsenite of lime by the hydrated lime and white arsenic loosely combining and then as the copper sulphate dissolves the formation of copper calcium arsenites which give the green color to the solution and to the resultant Bordeaux. The arsenite resulting from this procedure is very gelatinous, very adhesive, and an excellent insecticide. We have found it absolutely safe and effective. It is true

that it adds to the trouble of making Bordeaux and that it is not so handy as arsenate of lime. On the other hand, it is very cheap and effective and, when properly made, safe on foliage. A large number of farmers in New Brunswick have been using this mixture for the past three years with good satisfaction. We named the mixture of hydrated lime and dust collector arsenic "D. E. L. Mixture", the initials of the Dominion Entomological Laboratory where we worked the formula out.

As I stated in the beginning, just where to begin and where to end in such a paper as this is debatable. White arsenic is the basis for practically all of our arsenicals, but practically all purposes other than the ones I have outlined call for one or more factory operations before white arsenic can be made useful.

I can see no large use for white arsenic direct with the exception of its use in baits, especially in view of the wonderful improvements that are now being made in the cost of manufacturing combined arsenicals and in the arsenicals themselves.

CULTURAL CHARACTERISTICS OF CERTAIN SPECIES OF FUSARIUM.

by T. G. Major, B. S. A., M. Sc.

In undertaking these investigations the object has been to study the reactions of a number of species of the genus Fusarium (Link), found in root lesions, when grown under various cultural conditions. The difficulty of identifying an organism, even in pure culture, with descriptions in the literature, is well known since the medium is but seldom mentioned, and frequently the same fungus grown on two different media exhibits very different types of growth. This variation involves not only the type, amount and rate of growth, and colour production, but also the presence or absence of spores, size of spores and other microscopic characters. The investigations, the results of which are here presented in an abridged form, had the main object of determining to what extent an organism varies under known cultural conditions, with a view to its classification. In preparing this paper it has been found necessary to leave out most of the detailed results and to present only the methods, in brief, and the general results and conclusions reached. The original work itself was very limited in its scope, owing to the time factor, and the conclusions drawn can, at the most, only be regarded as suggestive.

Contribution No. 18, Dept. of Botany, Macdonald College, Que., being an abridgment of a thesis submitted to the Graduate School of McGill University, in partial fulfillment of the requirements for the degree of M. Sc., 1922.

The genus Fusarium possesses certain characteristics which make it specially adapted to a study of this nature. There are a large number of species, (Saccardo lists 401), and they are widely distributed in the soil. The spore types are very characteristic and the genus possesses the power of chromogenesis to a marked degree. The genus also exhibits a wide variation in characters when grown on artificial media. In addition to these factors, a great deal of work has been done in recent years on the taxonomy and pathogenicity of the genus Above all, the Fusaria appear to be becoming of increasing importance as producers of disease in economic crops.

Scope of work.

The investigations have been carried out under three main heads:—

1. The determination of a number of species of Fusarium isolated from various sources;
2. The study of their growth on various media;
3. The study of their growth at different concentrations of the hydrogen-ions in the media.

In determining the species the literature chiefly relied upon has been the classic monograph of Appel and Wollenweber (1: 1910), subsequent articles by Wollenweber (16: 1913), Sherbakoff's work on the potato Fusaria (12: 1915), and subsequent articles, based on these, by other investigators. Exact identification was not found possible in every case and in such an instance the species with which the organism most closely agrees is given. The growth characteristics of the various organisms isolated have been studied on as wide a range of media as possible, and observations made on the effect of tempareture. Detailed descriptions of the macroscopic and microscopic characters were made and from these observations certain tentative conclusions have been drawn. In order to secure data in regard to the effect of various concentrations of the hydrogen-ions in the media, a series of cultures were grown on media standardized to different PH values. The colorimetric method of PH determination described by Clarke and Lubs (5: 1917) and more fully by Clarke (4: 1921) was used.

Culture media.

In all, seventeen different media were utilized and they may be grouped under two main heads, namely, natural and synthetic. The first group consists chiefly of plant media, either in the form of steamed plugs or combined with agar. In the second group are a number of well known nutrient solutions, both in the liquid form and combined with agar. The media used are as follows:

1. Natural—(a) without agar—string beans, raspberry cane, potato, white carrot plugs and steamed rice.
   (b) with agar—iris leaf juice, potato juice, bean, and soil solution agars.
2. Synthetic. (a) without agar—Uschinsky's, Richard's modified, Duggar's and Harshberger's nutrient solutions.
   (b) with agar—dextrose 2%, dextrose 10%, laevulose 2%, Richard's and Uschinsky's solutions and Harshberger's with 2% dextrose.

Source and methods of isolation.

The species of Fusarium studied in this work were obtained from the roots of wilted aster, garden and sweet pea, and lupine, In addition, for purposes of comparison, three cultures were obtained from outside sources. The source of the different organisms in isdicated in the table following:

D—Sweet pea roots.
F—Aster stem (just below surface of soil).
G—Garden pea stem (obtained from Maine).
H—Aster stem (obtained from Maine).
J—Bean roots (obtained from Cornell).
K—Lupine roots.
L—Lupine roots.
N—Lupine roots.

G is a culture of *F. orthoceras* A & W., and H is *F. conglutinans* Woll., both originally isolated by Lewis (7: 1913) and obtained through the courtesy of Dr. W. J. Morse, of Maine University. J is culture of *F. martii phaseoli* Burk., originally isolated by Burkholder (2: 1919) and secured from Cornell University. F was isolated from a wilted aster in a garden in Notre-Dame de Grace, Montreal. The remaining organisms were secured in the vicinity of Ste. Anne de Bellevue, Que.

In the isolation work every effort was made to secure absolutely pure cultures. The roots of the wilted plants were washed and placed in moist chambers. A superficial growth of mycelium appeared over the surfaces. Transfers were made from different parts of the root systems (in case a number of species might be present) to tubes of agar. When there appeared to be more than one organism present the cultures thus obtained were carried for several weeks and transfers made.

In order to secure absolutely pure cultures, final isolations were made from each culture by means of the poured plate method. The transfers were made from single colonies when they appeared visible on the surface of the agar under a pocket lens (20 x). In most cases the cultures thus obtained were found to

be identical with the original cultures. In one instance, however, two different types of colonies appeared on the poured plates. Separate transfers were made and organisms K and L were made.

By means of this method seventeen pure cultures were obtained. As the experimental work progressed it became evident that a number of them were duplicates. These were accordingly discarded and the work completed with five isolations secured in the manner described and the additional three obtained from Maine and Cornell.

During the course of the investigations, stock cultures of the eight organisms were maintained, transfers being made approximately every three weeks. From these stock cultures subcultures were made on the various media used in the different experiments. Frequent microscopic examinations of these stock cultures were made as check on their purity. In no cases were any contaminations detected.

Classificaton of the organism studied.

The genus, in order to facilitate its study, has been divided into a number of sections by Wollenweber (16: 1913) and by Sherbakoff (12: 1915). The writer has grouped the organisms here studied according to these sections.

Section Elegans.

1. *F. orthoceras* A. & W. Wollenweber (16: 1923) gives the following diagnosis of this species: sporodochia and a reduced pionnotes present, inmasses salmon coloured, the conidia of both being 3-septate, up to 100%, 25-45 x 3.25-4.5 u, 4-septate, up to 25%, 5-septate up to 10%, where they are 40-50 x 3.75-4.75 u in size; sclerotia blue on steamed potatoes; slight lilac odour on steamed rice; common soil organism and a vascular parasite on many hosts, as, Solanum, Vigna, Pisum, Ipomoea, etc.

No. G in the series here studied agrees closely with this description. The lilac odour is not pronounced, however, and the colour is more of a cream shade than salmon. The 3-septate spores are 21.0-45.5 x 2.6-4.4 u, 4-septate, 35.0-42.0 x 3.5-5. 2 u. Only a single 5-septate spore was observed and it measured 45.5 x 4.4 u.

2. No. F differs in some respects but as a whole coincides fairly closely. It is a more vigorous organism in amount and rate of growth and spore production than G, but when colour is produced in the medium (wine-red on rice) the latter organism gives a more intensive hue. The 3-septate spores measure 22.5-52.5 x 2.6-6.1 u, 4-septate, 35.0-49.0 x 3.5-6.1 u, 5-septate, 38.5-52.5 x

4.4-6.1 u. While these measurements fall fairly well within the limits given for G, the 3- and 4-septate types average higher, as the following table shows :

	3—septate	4—septate
No. F	35.6 x 4.3 u	43.6 x 4.6 u
No. G	32.7 x 3.6 u	36.2 x 4.6 u

No. G produced typical conidia of the Elegans type on bean, Uschinsky's and Richard's agars, and on potato plugs, while in 3. *F. conglutinans* Woll.—Wollenweber (16: 1913). This species differs from *F orthoceras* in the absence of a wine red colour on rice, No. H has all the typical characters of this species, namely, 3-septate spores measuring, 24.5-42.0 x 2.6-4.4 u, averaging 32.7 x 3.9 u, 4-septate forms, (observed only on bean agar), averaging 50.0 x 4.4 u. The production of aerial mycelium is very scanty and, generally speaking, the organism appears to be lacking in vigour probable by reason of the length of time it has been carried in culture.

Section Gibbosum.

4. *F. gibbosum* A. & W.—Appel and Wollenweber (1 1910), Sherbakoff (31: 1915). Diagnosis-conidia often with hyperbolic dorsal curve, breaderin middle, long narrow apex, pedicellate, typically 5-septate, 40.0-46.0 x 4. 4-4.7 u, (averaging 41.6 x 4. 6 u), also 0- to 7-septate, in minute sporodochia or spreadin over the mycelium singly, hyaline to light pinkish cinnamon; chlamydospores intercalary: short fine ærial mycelium present; zonation; substratum onpotato agar pale flesh to cinnamon.

No. K. differs from this in the following respects:—conidia typically 3-to 5-septate, the fomer measuring 17.5-38.5 x 3.5-6.1 u, (averaging 28.1 x 4.4. u), and the latter, 28.0-57.5 x 3.5-6.1 u, (averaging 43.3 x 4.8 u); colour on potato agar golden brown. In other characters No. K is practically identical with *F. gibbosum* and it may possibly be variety occurring on Lupinus.

5. *F. Lanceolatum* Pratt—Pratt (10: 1918) gives the following diagnosis of this species;—conidia typically in pseudopionnotes, also in aerial mycelium and sporodocdhia, from nearly straight to strongly curve, pedicellate, typi--cally 3—to 5-septate, rarely higher, 3-septate measuring 22,0—52.0 x 2.5—5.0 u, (34.0 x 3.5 u), 4 septate, 22.0—60.0 x 2.8—5.0 u, (40.0 x 4. 8 u), 5 septate, 36.0—70.0 x 2.8—5.7 u, (48.0 x 4.1 u); scanty aerial mycelium, sporodochia and pseudopionnotes ochraceous orange at first, later becoming reddish; substratum on rice yellow to dark brown; chlamydospores single and in chains; isolated from the soil.

No N differs from this in certain points:—the conidial measurements are : 3 septate, 21.0—45.0 x 2.6—6.1 u, (31.6 x 4.3 u), 4 septate, 28.0—49.0 x 2.6—6.1

u, (37.3 x 4.6 u), and 5 septate, 31.5—52.5 x 3.5—6.1 u, (40.1 x 4.6 u). The production of deep shades of red by the conidial structures has not been observed, but salmon pink and orange are produced on several media. While it scarcely can be said to be scanty the production of aerial mycelium is far from plentiful. Of the various species described in this section, *F. lanceolatum* appears to agree more closely with No. N than any other. The question again arises as to whether or not these differences noted above are of specific or even varietal importance, but further study will be necessary before a decision can be reached in this regard.

Section Martiella.

6. *F. martii phaseoli* Burk.—Burkholder (2: 1919). Macroconidia mostly 3-septate, (44.5 x 5.1 u), 4 septate (50.09 x 5.3 u), rarely 5 septate, of nearly even diameter throughout, more or less curved near the apex apedcellate. Microconidia rare. Aerial mycelium scanty and white. Spore in pseudopionnotes. Chlamydospores terminal or intercalary, single or in short chains. Shades of green ,blue and purple in culture. Causes dry rot of roots of *Phaseolus vulgaris* and other Phaseolus spp.

No. J. agrees with this description in every respect, except that the spores appear to be slightly smaller, 3 septate, 24.5—52.0 x 2.6—7.0 u (40.5 x 4.9 u) and 4 septate, 40.2—56.0 x 4.4—6. 1u (49.5 x-5.5 u). The character for colour production is not strongly are quite faint.

7. *F. solani* (Mart.) Sacc.)—Appel and Wollenweber (1: 1910) and Sherbakoff (12: 1915). Microconidia always present on aerial mycelium. Macroconidia somewhat broader in upper half of lenght, rounded to slightly constricted apex, non or slightly pedicellate, typically 3 septate, 27.0—34.7 x 5.4—5.8 u (29.75 x 5.5 u), also 4 and 5 septate. Aerial mycelium poorly developped, white to olive buff. Substratum on potato agar oli ve buff with green blue tinge. On tubers of *Solanum tuberosum.*

No. L of this series closely with this description. It is an outstanding organism especially in the number of spores produced, masses of spores being developped on practicelly every meduim used. In some cases the entire surface of the culture is made powdery by the presence of tremendous numbers of spores. They are very uniform in shape and size, measuring, 3 septate, 24.5—42.0 x 3.5—7.0 u (31.6 x 5.6 u), 4 septate, 31.5—44.0 x 5.2—7.0 u (36.2 x 6.2).

8. *F. lathyri* Taub.—Taubenhaus (14: 1914). Macroconidia sickle shaped slightly curved, 3 to 4 septate, mostly 3 septate, latter measuring 15.8—30.8 x 4.2—5.6 u. Microconidia elliptical to oval. Chlamydosphores spherical, thickwalled, spinulate when old, borne singly or in short chains. Causes wilt and root-rot of *Lathyrus odoratus.*

No. D appears to be the same organism. It was isolated from the roots of wilted sweet peas, and, all the writer was unable to secure infection with it, it agrees very closely with the description given by Taubenhaus for *F. lathyri*. The macroconidia are typical in shape, from 2– to 5–septate, mostly 3–septate, which measure 17.5—35.0 x 2.6—6.1 u (29.5—4.2 u) The chlamydospores are comparatively small, round, and occur singly, in short chains, and in small clumps.

Growth on various media.

In the limited time available it will be impossible to give the detailed results of the various experiments carried out under this hand. A brief discussion of these results will be all that is possible.

a. Effect of the medium on growth character s.

There is a wide variation in the type of growth from an entire lack of aerial mycelium with a tough leathery surface layer, as *F. Orthoceras* on iris leaf juice agar, to dense aerial growth, as *F. solani* on Richard's solution. All gradations between these extremes may be found and the different organism have various abilities in this regard. The vigour of the organism is possibly involved, a vigourous one producing aerial growth on more media.

Colour varies widely within each species. It may be present on one medium and absent on another. The intensity also varies. However, there seems to be a typical fundamental colour for each organism which will be produced to some degree when any colour is present. The vinaceous colour of *F. orthoceras* is an example of this. Harshberger's nutrient solution agar with 2% dextrose is the best medium for colour production.

The character of the mycelium varies greatly but not constantly, and consequently this charactere is suseless from the taxonomix standpoint. There are variations in the width of the hyphea, cell length, and protoplasmic content.

The production of chlamydospores is usual on certain types of media and seems to be associated with a lack of proper nutrition. The sugar agars and Harshberger's solution agar are examples of this type of medium. There is a variation in the size, number and contents of these structures.

The conidia from one of the most variable characters. Microconidia and macroconidia appear on the different media in varying proportions. An abun dance of conidia is seldom found when large numbers of chlamydospores are present. The size of the macroconidia and their septation appear to vary about a more or less constant, mean, and consequently the more measurements that are taken the more nearly will this mean be approached . The great variation in the percentages of the different types of septation also makes the observation

of large numbers advisable if the results are to be of any value for comparative purposes.

b. Effect of temperature.

Within the limits studied (20°c—28°c) certain facts are quite clear in regard to the effect of temperature. The amount of aerial browth dependas on the temperature but not constantly for all species, in some cases more being produced at higher than lower and vice versa, as, for example, *F. gibbosum*, which produces more growth at 25°c that at 20°c on Uschinsky's solution, while *F.* Orthoceras produces more at 20°c. Larger spores may be produced at higher temperatures. A more intensified colour is quite characteristic of the growth at higher temperatures. More fungus material (dry weight) is produced at 25°c than at 20°c.

Growth at different concentrations of the H-ions in the media.

In order to secure data on this factor a series of cultures were grown on media (Duggar's and Harshberger s'solutions) standardized to different PH values. Clarke's colorimetric method was used.

The experiments brought a number of interesting facts to light. In the first place it is apparent that the effect of the H-ion concentration depends both upon the medium and the organism. *F. orthoceras* (F and G) shows no differences in growth characteristics on either Harshberger's or Duggar's solutions. The other three species used in this phase of the work, namely, *F. martii phaseoli*, *F. lathyri*, and *F. gibbosum*, show differences but not constant ones, as is shown by the least mentioned organism, which, at the higher PH values on Harshberger's produces large numbers of macroconidia ,while on Duggar's ,at similar values it fails to produce any. This supports the results obtained by Webb (15:1919), and Zeller, Sehmitz and Duggar (17:1919).

The second interesting fact is in regard to colour production. Within the limits studied colour production does not appear to be related to the H—ion concentration, but to depend mooe upon the composition of the medium. F. orthoceras (F and G) and *F, martii phaseoli* (J) produce a uniform colour on each medium throughout the whole range of PH values, but a different intensity on each medium in each case. In the case of *F. lathyri* (D) and F. gidbbosum (K) there seems to be a gradation in the intensity of the colour and the amount present. It must be remembered, however, that there is a similar gradation in the amount of growth exposed to free air in these cultures. Whether this gradation is due to the increasing PH values or not is a question. The character is so variable that a definite conclusion is impossible. It appears, however, that the colour intensity depends on the amount of free air present rather than on the

PH value of the medium. Burkholder (2: 1919) makes a similar statement in connection with his study of *F. martii phaseoli.*

Generally, speaking, therefore, the concentration of the H-ions in the medium does not appear to be the only limiting factor for growth characteristics, but is of importance when taken in conjunction with other factors, such as temperature, and the composition of the medium.

Summary.

1. *F. lathyri* Taub. has been isolated from the roots of wilted sweet peas *F. gibbosum* A. & W.,*F. lanceolatum* Pratt. and *F. solani* (Mart) Sacc,from wilted upines, and *F. orthoceras* A. & W., from wilted asters.

2. These species, and in addition, *F. martii phaseoli* Burk. *F. conglutinans* Woll. and another strain of *F. orthoceras* A. & W., have been studied in culture, to determine the effect of various media. The temperature,and the H-ion concentration of the medium on the various growth characters.

3. The type of growth varies on different media from a complete absence (*F. orthoceras* on iris leaf juice agar) to a profuse production of aerial mycelium (*F. solani* on Richard's solution).

4. The colouration varies both in intensity and in the actual colour produced.

5. The production of chlamydospores appears to be related to poor nutrition and is characteristic of such media as Harshberger's solution agar and the different sugar agars.

6. The type and proportion of conidia present and the size of the macroconidia present appear to very about a more or less constant mean.

7. The total amount of fungous growth is greater at 25°c than at 20°c on ischinsky's solution for all the species studied.

8. More intense colours are usually produced at the higher temperature.

9. The spore size is only slightly and not constantly influenced by the temperature.

10. The production of aerial growth is usually greater at 25°c that an 20°c but again this is not constant, differing both with the organism and with the medium.

11. Some organisms show a gradation of growth characters with varying H-ion concentration on the same medium, e.g., *F. lathyri*, *F. martii phaseoli* and *F. gibbosum*. On the other hand, *F. orthoceras* (both strains) does not show this gradation . It appears, therefore, that the H-ion concentration of the medium is not the only factor affecting growth characteristics.

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PLATE IV

White Birch on the Driveway, Ottawa, partially destroyed by Borer (*Agrilus anxius*).

White Birch at Ottawa destroyed by Borer (*Agrilus anxius*).

Eggs of Bronze Birch Borer (*Agrilus anxius*) x 9 diam.

SOME BIOLOGIC OBSERVATIONS ON THE BRONZE BIRCH BORER AGRILUS ANXIUS GORY.

By C. B. Hutchings, Assistant Entomologist, Division of Forest Insects, Department of Agriculture, Ottawa, Canada.

The Bronze Birch Borer is one of the worst enemies of the Birch. Extensive observations made by the Division of Forest Insects of the Entomological Branch, at Ottawa, in different parts of Ontario and Quebec point to the widely spread ravages of this pest in Canada. It has also been reported as operating seriously in many of the Eastern and Middle States of America. Not only are the cultivated birches--those grown under more restricted conditions in private gardens and parks—subjected to severe attack, but those found in the forest wilds in their natural habit alike fall a ready prey to the *Agrilus* beetle. In and around Ottawa the various species of this shade tree have been infested for many years. The cut-leaf varieties have suffered the most, although no species appears to have been entirely immune. At the Central Experimental Farm, in the Driveway, and in many of the city gardens handsome large birches are being gradually killed off in this way. During some seasons the attacks are of less severity. This may be due to various agencies, such as weather conditions, health of host, parasites and birds. It has been found that a cold deferred spring will keep back the development of the larvæ and delay the adults coming to the exterior, while a wet summer will tend to increase the vigour of the tree so that its powers of resistance to withstand insect attack are increased.

The damage is all done in the larval stage and is of such an insidious character that often the presence of the insect cannot be detected until it has become well established within the host. When once a tree is attacked, its fate is sooner or later, a foregone conclusion. One of the first signs of the presence of the borer is the drooping of the topmost branches as if these had been wilted by fire or girdled. Gradually they die off and present a stag-head appearance, while the rest of the tree appears to be healthy, green and vigorous. The attack having begun in the head of the tree, continues on downwards, branch after branch, wilting and dying off in turn as the larvæ eat their way into the fresh, succulent bark until the entire trunk and all the under branches have been completely covered by a net work of very intricate tunnellings.

Unlike many of the important wood borers, such as *Cyllene robiniae* on locust, *Goes pulcher* on hickory, *Monochamus marmorator* on balsam, *Prionoxystus macmurtrei* on red oak,all of which indicate their presence by the piles of sawdust found ejected at their tunnels' entrance, *Agrilus anxius* exhibits no such index of its presence and except for a very little frass pushed out early in its career

packs the tunnel tightly behind it with borings as it goes forward. However, the larvæ show other signs quite distinctive,and one of these is a certain wavy character of the bark. The outer surfaces of the branches and trunk may often be raised in small undulations due to the operations of the grubs as they tunnel just below in the outer bark. Another good sign is the presence of dirty, reddish-looking patches on the white bark surfaces, often with rusty-coloured sap trickling from them. These spots are quite small at first but later may reach a size of several square inches, presenting very unsightly markings which greatly detract from the beauty of the tree.

The adult belongs to that destructive group of wood-boring insects, the Buprestids which are commonly known as metallic beetles. It is slim in outline, olive-bronze in colour and about 10mm long. The sexes are quite similar in appearance except that the male has a slight depression on the first abdominal segment. The beetles are very active specially during the bright warmer parts of the day. They fly rapidly from branch to branch and chase one another up and down the bark with great alacrity. They have a habit of raising the wing covers as if about to fly and of stretching and exposing themselves to the direct sunlight where they will lie basking for long intervals at a time. If approached, even very cautiously, they at once display signs of uneasiness; and if in the slightest way disturbed will fly away quickly , disappearing as by magic. At other times they will dodge the observer from side to side of the trunk in order to elude him. If approached near enough to be touched, they almost invariably feign death and drop to the earth; although occasionally they hold tenaciously to the bark surfaces and will not give up except forced to do so.

Under close conditions in the laboratory, mating was commonly observed. This occurred early in June and egg laying began immediately afterwards. Fresh birch sticks were cut and placed in the cages for the beetles to oviposit on. The females would examine the surface of these with great interest, feeling the bark with their short serrate antennæ, running rapidly from one depression to another, probeing these with their long ovipositors as they sought suitable locations to deposit their eggs.

Oviposition was carried on during the warmer parts of the day, the bright sunshine being a marked simulant for activities.

It was the writer's good fortune to discover the eggs of *Agrilus anxius* during summer of 1920, after several seasons study on this problem. The original description is now given here for the first time. The egg is oval in outline, much flattened on two sides, length1.25 to 1.50 mm.; width.75 to 1 mm.; chorion soft, wrinkled and finely reticulated; pale cream-white when first laid changing to yellowish tints, chiefly at the pole ends. Adheres well to the surface and is coated over with a very thin, semi-transparent white filament. This last is

applied after deposition as a cement to protect the soft shell during incubation. In the accompanying illustration one of these menbranous coatings will be seen detached on the left of the group of eggs. A specially designed cage 12″ x 12″ x 14″ with glass sides was used in connection with this work.

On hatching, the small larva 2 mm. in length, leaves the shell from the underside of the egg and enters the bark at a point immediately below. The minute cuttings and frass are passed back into the shell case from which emergence has recently occurred and tunnelling begins at once. The young legless grub slowly starts to eat its way down to the softer and more sappy areas, leaving behind a very fine almost threadlike way of progress. This line of route may be straight, winding or very tortuous; but usually it is fairly direct at the start. Later on it becomes sinuous and very irregular, and where several larvae are working together, as often happens, the tunnels cross and interlace in such confusion that it is impossible to trace any particular one for any length A closer study of the tunnels reveals certain slight enlargements here and there along the line. These recesses mark the places where the larva has moulted and as may be expected the distance apart of the first moults is small, but the stadium increases gradually as the larva gets bigger. Five moults are required to bring the larva to matirity. It is then a flat, legless grub, dull white and about 22 to 25mm. long. The last resting point is important. The larva constructs in the woody area near the outer surface, a boat-shaped cell in which it transforms. The beetle afterwards cuts its way to the exterior and emerges through a lunar shaped or D-shaped hole on the bark, a characteristic which is common to this genus, completing its lifecycle in one yard.

Some observations were made in feeding and it was found that the beetles partook sparingly of birch foliage. An effort was made to determine what degree of preference was shown for various shade trees, and it was noticed that a marked liking was exhibited for poplar, the leaves being freely eaten, specially the young ones; while willow was next in choice and birch came last and was scarcely touched. Elm they would not eat, nor any of the conifers. These beetles are edge feeders, that is, they nibble small pieces from the leaf margins, cutting out semi-circular patches here and there, as they go, seldom, if ever severely attacking any one leaf.

No effective control has as yet been devised for this pest despite considerable work having been done toward this end. Severe pruning will tend to check the spread of the beetles; but this is only a temporary measure and in the end leads to the inevitable destruction of the tree. Where birches are planted in large numbers along driveways, in parks and groves, it is well to take drastic action by cutting out the infested tree and burning trunk and branches early in

the spring before the buds are out. This will prevent the beetles going to the other trees nearby.

Washes for the trunk are unsatisfactory, chiefly because of their staining the bark; and spraying is of no avail. Hymenopterous parasites are undoubtedly the greatest natural controlling agency. Every year considerable numbers of the small chalcid fly, *Phasgonophora sulcata* Westwood, were to be found breeding in the birch sticks. This parasite is of first importance in control of *Agrilus anxius*. There are also several species of Siricidae, horntails, which attack the larva. No doubt birds play an important part in control. The downy woodpecker, chipping sparrow, phoebe, king bird and two species of warblers have been observed at the Arboretum, Central Experimental Farm, among the branches of *Betula ulmifolia* and *B. fruiticosa*, both of which were very heavily infested with *Agrilus*.

To sum up very briefly:—*Agrilus anxius* is perhaps the most serious insect enemy of the birch family. Injury is done in the larval stage, by a series of winding tunnels beneath the bark thus girdling and eventually killing the branches and trunk. No effective artificial control is known, but certain natural agencies, such as parasites and birds play a good part. Infested trees should be cut down and burned in the early spring. It is, therefore, very unsatisfactory to plant birches of any variety for ornamental or shade purposes and we do not recommend the practice.

BLUE STEM OF THE BLACK RASPBERRY.

By J. F. Hockey Laboratory of Plant Pathology, St. Catherines, Ont.

This disease has not been previously reported from the Niagara district Probably few are acquainted with it because of the comparatively little attention paid to black raspberries in this section. The blue stem condition as described by W. H. Lawrence (Wash. Agr. Expt. Sta. Bul. 108, 1912) was found this season in various patches through the district and in isolated seedling plots at the Horticultural Experiment Station, Vineland.

In most cases the entire plant was defoliated or nearly so, in the latter case the remaining leaves were yellowish and drooping. Occasionally a plant was found with one or two canes apparently dead whereas the remaining canes showed the blue colorations developing along the base of the stems with the tips of the canes still normal. The color of the diseased stems is a bluish purple to black

On a macroscopic examination of the diseased canes in the field and laboratory no superficial fungous growth could be observed. This appeared only when the specimens were placed in moist chambers. An examination of free hand sections of the stems revealed the presence of strands of mycelium in the wood elements. Some of the tracheae were completely plugged with mycelium No evidence of internal fruiting bodies have been found in these examinations.

Specimens of diseased canes were placed in moist chambers in order to observe any fungous growth which might take place and especially the predominate growth on cut surfaces of the canes.

Small pieces of the internal tissue were used in making initial cultures on nutrient agar. These cultures yielded a very predominant fungous growth closely resembling that isolated by Lawrence in Washington and described in 1912 as *Acrostalagmus caulophagus*, Lawrence. Typical verticillate conidiophores were produced in abundance, bearing at their tips heads of conidia enclosed in droplets of hygroscopic slime which disappears in solution immediately when placed in water.

The specimens placed in moist chambers yielded the same fungus on the cut surfaces, fruiting abundantly. On the bark too were found minute scattered tufts 0.25—0.5mm. in diameter and height, which on close examination were found to be the conidiophores of this fungus. The heads of conidia varied in diameter from 10-30u with the average from 10-15u. These contained many hyaline spores, oblong to oval in shape and from 3-8ux2-4u in size.

There is still doubt as to the specific name of this fungus. Carpenter (Jour. Agr. Res. 12, 9: 529-546, 1918) is strongly of the opinion that the fungus described by Lawrence as *A. caulophagus* does not differ from *Verticillium albotrum* (R. and B.) sufficiently to warrant the adoption of another name.

In U. S. D. A. Plant Disease Bulletin for Nov. 1, 1922, Dr. C. L. Shear reports the presence of this disease in Michigan, having isolated the fungus from material collected in that state. The presence of blue stem in Ohio and New York State is also reported by R. B. Wilcox and W. H. Rankin respectively. In the same Bulletin an infectious blue stem distinct from that described by Lawrence is reported prevalent at Geneva, N. Y. This condition has not been observed in the Niagara district this year, as all material collected has yielded the same fungus in culture.

SOME RESULTS FROM SPRAYING & DUSTING APPLES IN QUEBEC.

By C. E. Petch, Dominion Entomological Laboratory, Hemmingford, Que.

During the past four years four spraying systems have been tested in the same orchard on the same variety. The variety chosen was Fameuse, because it is very susceptible to apple scab (Venturia pomi) and many of our common insects, especially apple maggot (Rhagoletis pomonella).

The spraying schedules used were as follows:

PLOT NO. 1—NOVA SCOTIA SPRAY CALENDAR

Green Tip Spray —Bordeaux 3-10-40+arsenate of calcium 1 lb
Pink Bud Spray —Bordeaux 2-10-40+arsenate of calcium 1 lb
Calyx spray —Soluble sulphur 1 lbs; hydrated lime 5 lbs; cal. ars. ½ lb
After calyx spray—Bordeaux 2-10-40—arsenate of lime 1 lb.

PLOT NO. 2—ONTARIO SPRAY CALENDAR

Green Tip spray —Lime sulphur 1 gal. to 20 water
Pink Bud spray —Lime sulphur 1—40+arsenate of lead 1½—40
Calyx spray —Lime sulphur 1—40+arsenate of lead 1—40
After calyx spray—Lime sulphur 1—40+arsenate of lead 1 lb—40

PLOT NO. 3

Green tip spray —Lime sulphur 1.008 sp. gr.+calcium arsenate ¾ lb—40
Pink bud spray —Lime sulphur 1.007 sp. gr.+calcium arsenate ¾ lb—40
Calyx spray —Lime sulphur 1.006 sp. gr.+calcium arsenate ¾ lb—40
After calyx spray—Bordeaux 3—10—40 +calcium arsenate 1 lb—40

PLOT NO. 4

Pink bud spray —Lime sulphur 1.010 sp. gr.+calcium arsenate ¾ lb—40
Calyx spray —Lime sulphur 1.009 sp. gr.+calcium arsenate ¾ lb—40
After calyx —Lime sulphur 1.007 sp. gr.+calcium arsenate ¾ lb—40
Spray 2 weeks later—Lime sulphur 1.007 sp. gr.+calcium arsenate ¾ lb—40

As often as possible the applications were made on the same day and there was never over 24 hours between any of them. The average of the injuries for the past four years has been as represented in the following table:—

PLOT	SCAB	INSECT INJURY	RUSSETING	FOLIAGE INJURY
No. 1	1.86%	2.5 %	9.25%	2.5 %
No. 2	1.39%	2.0 %	0.0 %	3.75%
No. 3	.85%	1.63%	1.25%	2.50%
No. 4	1.34%	1.55%	0.0 %	4.25%

The average cost of 100 gallons of the mixtures for the past 4 years has been as follows:

YEAR	PLOT 1	PLOT 2	PLOT 3	PLOT 4
1919	5.00	4.31	4.32	3.93
1920	5.43	5.91	4.44	3.93
1921	3.37	4.85	3.74	3.91
1922	3.24	6.09	3.62	3.35
Average	4.26	4.79	4.03	3.78

During this four year period the injury to the foliage has been slightly more in the lime sulphur plots but this has been far surpassed by the injury to the fruit by the use of Bordeaux mixture. The Bordeaux mixture used was not the ordinary 4—4—40 but one containing a small amount of copper sulphate and an excess of lime. Bordeaux injury was most injurious when wet weather followed the application. Considerable trouble is experienced through clogging nozzles, etc. when using this Bordeaux because of the large amount of lime present. It is usually more costly and not as convenient to use as lime sulphur. This past year the Bordeaux sprayed plot had 6% of scab whereas the lime sulphur plots had less than 4%. This result was due to the use of soluble sulphur in the calyx spray, and to our infestation of scab coming between the calyx and after calyx applications. It would seem the use of soluble sulphur for the calyx spray is the great weakness of the Nova Scotia spray calendar and this point would have been more clearly brought out if there had been a heavy infestation of scab here this past year.

Calcium arsenate has given equal results to lead arsenate in insect control but it has advantages which make it preferable. It is less costly and does not cause any appreciable chemical change when mixed with lime sulphur. In 1921, lead arsenate in combination with lime sulphur injured a large number of apples chiefly at the calyx end. The injury was usually in the form of a circle but in severe cases streaks formed on the sides of the apples. The skin was cracked and turned to a dull brown color. This type of injury did not occur in orchards sprayed with calcium arsenate and lime sulphur.

Dry lime sulphur has been tested the past two years on McIntosh and Fameuse apples with the following results:

1921. Dry lime sulphur 2 lbs—water....40 gals. (3 applications)
Fameuse........................39.9% scab
McIntosh........................3.45% scab
1922. Dry lime sulphur 3 lbs to 40 gals water (3 applications)
Fameuse........................14.0% scab
Dry lime sulphur 4 lbs—40 gals water (3 applications)
Fameuse........................11.1% scab
McIntosh........................20.8% scab

These results show that this material has not given satisfactory control of apple scab on our most important varieties. When used at a strength over 3 lbs to 40 gals. it is more costly than commercial liquid lime sulphur. From my experience it has no advantages in handling. The only place for its use at the present time is with the very small grower, where the quantities used would be trifling.

Dusting continues to give satisfactory results in some orchards and this year in one orchard apple scab was present on only 1% of the Fameuse apples. In this orchard the expensive mixtures were not used but mixtures containing 50% sulphur 45% talc or hydrated lime and 5% insecticide. The use of these diluted mixtures reduced the cost almost 50%. The use of Bordeaux dusts has given bronzing and russetting every year and it has been decided not to recommend their use in this province. Calcium arsenate has been used at rates of 5% to 10% of the mixtures containing no hydrated lime and there has not been any foliage or fruit injury during the past six years. Materials for increasing the adhesion of dusts to foliage and fruit are greatly needed but to my knowledge there are none known at the present time which are satisfactory. Among the many things tried wheat flour was the only one that gave promise of being worth while in orchard dusting. Further experiments with wheat flour at various strengths are to be carried out in 1923.

The above remarks are relative to this province and I would advise those living outside Quebec not to adopt any of the above mixtures in a commercial way unless they have been tested and found satisfactory for their conditions.

RESULTS OF ONION MAGGOT CONTROL WORK, 1922.

By W. J. Tawse, Dept. of Horticulture, Macdonald College.

The onion maggot (*Pegomyia ceparum*, Bouche) control work was again carried on under field conditions both at the College and with co-operating market gardeners around Montreal. The pan system of setting out the poisoned bait was used entirely as the diagonal spray was too costly, both as regards time and material and further under local climatic conditions the results were very uncertain. The dry hot winds at this period of the growing season have completely evaporated other sources of moisture and in consequence the maggot flies or adults are quickly attracted to the pans of poisoned bait.

It is to be regretted that Mr. Sauvé on the Côte des Neiges Road was unable to carry on the experiment after setting out the pans and filling them

once; but due to the expiration of his lease and the possibility that it would not be renewed, he allowed all work to lapse. We hope now that it has been renewed that he will cooperate in 1923.

The materials used including the poison, sodium arsenite and molasses, as well as the pans, were furnished by the growers themselves. They found the work done in 1921 was a distinct profit to them and were very pleased to furnish material and carry out the necessary work according to our directions.

The following tables will give a clear understanding of the work carried on at the College and in Rosemount. It was also thought advisable to append the temperature observations for the month of May and June as some periods in May were very hot and dry, while June was marked by a higher precipitation than usual.

Onion Maggot Control.

Date Sown	Dates of Application	Amount of Material and Labor	Remarks
April 25th-26th	May 23rd	30 pans. 3¼ gals. 1 hr.	Excellent germination of seed and very thick stand. First eggs were found May 24th on trap onions. May 26th numerous eggs on trap plants but none on field crop.
	May 27th	30 pans. 3½ gals. ½ hr.	Weather has been hot with thundershower on the 25th. Cooler on the 27th, then warmer again.
	May 31st	30 pan . 4 gals. ½ hr.	Fine and warm. Flies observed sipping poisoned liquid.
	June 5th	30 pans. 4 gals. ½ hr.	Showers and very warm. Crop looks excellent. Pans evaporating quickly.
	June 10th	30 pans. 3½ gals. ½ hr.	Showers after a very dry period and cooler. Adult flies very numerous and first maggot injury found in untreated plots.
	June 14th	30 pans. 3½ gals. ½ hr.	Maggot injury in plots very light Adults very numerous. Increased sodium arsenite to ½ oz. per gal. which seemed to attract and kill the adults much quicker. Counted 50 dead by night in and around one pan.

June 20th, the pans were collected and cleaned ready for next year.

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May.

Day of month	Maximum Thermometer	Minimum Thermometer	General state of weather: Midnight to noon	General state of weather: Noon to Midnight	Remarks	Depth at morning observation. Rain.	Depth at evening observation. Rain.
1	64.0	36.5	Clear	Clear			
2	69.0	44.0	"	"			
3	63.5	44.5	"	"			
4	64.0	46.5	"	Rain			.34
5	50.0	44.0	Rain	Cloudy		.58	
6	57.5	42.5	Clear	Rain			.20
7	61.0	46.0	Showers	Showers		.03	.08
8	61.5	45.0	Clear	Clear.			
9	69.0	45.5	"	"			
10	74.0	48.0	"	"			
11	65.0	45.5	"	"			
12	63.0	44.0	"	"			
13	68.0	44.5	"	"			
14	70.5	43.0	"	"			
15	71.5	48.0	"	"			
16	71.5	43.0	"	"			
17	69.5	46.0	"	"			
18	70.5	47.0	Clear	Rain	Showers		.20
19	69.5	49.5	Rain	"	"	.08	.19
20	65.0	56.0	"	Clear	"	.05	
21	69.0	57.0	"	"	"	.02	
22	68.5	46.5	Clear	"			
23	70.5	45.5	"	"			
24	77.5	46.0	"	Rain	Showers		.25
25	80.0	46.0	Rain	Clear		.07	
26	72.0	52.0	Clear	"			
27	69.5	42.0	"	"	Very cold north wind		
28	77.5	43.5	"	"			
29	78.0	54.5	"	"			
30	69.0	50.5	"	"	Smoky from		
31	84.0	48.0	"	"	forest fires.		
Sums	2130.0	1440.5					
Means	68.7	46.4				.83	1.26
					Total pre	cipitation	2.09

June.

1	74.5	64.5	Clear	Cloudy.			
2	75.0	47.5	"	"			
3	75.0	57.5	Rain	Rain		.74	.07
4	79.0	59.0	Clear	Clear.			
5	84.0	56.5	"	Rain			.15
6	79.0	63.0	Cloudy	Clear.			
7	84.5	62.5	Clear	"			
8	87.5	66.0	"	"			
9	63.0	58.5	Rain	Cloudy		.28	
10	71.5	55.0	Cloudy	Rain			.13
11	72.5	56.5	Rain	"		.50	.31
12	59.0	56.5	"	Cloudy		.08	
13	64.0	45.5	Clear	Clear.			
14	65.0	47.0	Cloudy	"			
15	73.5	52.5	Clear	"			

June—*Continued.*

Day of month	Maximum Thermometer	Minimum Thermometer	General state of weather: Midnight to noon	General state of weather: Noon to Midnight	Remarks	Depth at morning observation. Rain.	Depth at evening observation. Rain.
16	74.0	53.5	"	Cloudy.			
17	67.0	53.5	Rain	Rain	....	.39	.78
18	57.0	53.0	"	"	....	.10	.02
19	69.0	54.5	Cloudy	Clear.			
20	74.5	54.0	Clear	"			
21	68.0	60.5	Cloudy	Rain	....	....	.07
22	61.0	59.5	Rain	"	....	.59	.95
23	72.0	55.0	"	Clear	....	.04	
24	85.5	58.0	Clear	"			
25	76.0	68.5	"	"			
26	73.5	52.5	"	"			
27	71.0	60.0	"	Rain	....	....	.79
28	76.0	50.5	"	"	....	....	.07
29	71.0	61.0	Rain	"	....	.18	.05
30	79.0	60.0	Clear	Clear.			
Sums	2181.5	1702.0				2.90	3.39
Means	72.7	56.6				Total precipitation.	— 6.29

Onion Maggot Control, 1922.—Mr. J. J. McEvoy, Rosemount, Que.

Date sown	Date of application	Amount of material used per acre	Labor	Remarks
Two acres in front of storages on April 25th 1922.	May 24th....	25 pans. 3 gals..	50 min..	Onions were grown here previous years. Seed sown in rows 12" apart. Vilmorin seed which germinated very poorly and left only a thin stand of plants. Trap plants were planted near pans.
	May 27th....	25 pans. 3 gals..	25 min..	Windy and drying winds which evaporate pans very quickly.
	May 31st....	25 pans. 3½ gals..	25 min...	Many eggs observed on trap plants. Numerous dead flies around and in the pans.
	June 7th.....	25 pans. 3½ gals..	25 min...	Ninety-six dead flies inside and around one pan not to mention other species and millers.
	June 11th....	25 pans. 3½ gals.	30 min..	Cut-worms working around edge of field were quickly stopped with poisoned bait.

Onion Maggot Control, 1922.—Mr. M. McEvoy, Rosemount, Que.

Date sown	Date of application	Amount of material used per acre	Labor	Remarks
4 acres below orchard sown May 1st, 1922.	May 24th....	20 pans. 4 gals....	1 hour..	Onions were sown with two seeders one sowing much thicker than the other, but there was a very even strong stand of plants
	May 27th....	20 pans. 4 gals....	½ hour..	Adult flies were observed on the 20th. Four eggs were found on trap onions on the 23rd. Adults were observed on the pans on the 27th.
	May 31st....	20 pans. 4 gals....	½ hour..	Pans evaporating very quickly.
	June 6th.....	20 pans. 5 gals....	½ hour..	Thirty-seven adults found around on pan. All pans gave high counts of dead adults. First wilting onions are now appearing close to heavily infested in area 1921.
	June 11th....	20 pans. 5 gals....	½ hour..	Fifty-seven dead adults found around one pan. Onions are looking splendidly and very few appear to have been damaged by the maggot.

This grower also treated another large block of onions four hundred yards further down his farm and here again excellent control was recorded with the exception of one end of the block, which was aaross the road from a heavily infested block in 1921. Trap onions were not planted beside the bait pens in this block and more plants were infested with the maggots than where the trap onions were used.

The several species of cutworm were more prevalent than for many years and completely wiped out the onion, carrot, beet and part of the turnip crops growing in Mr. Paul Wattiez's garden in Outremont. Where this injury occurred careful allowance was made so as not to confuse it with damage caused by the onion maggot.

One interesting observation on the poisoned bait which was noted by all workers was the advantage of increasing the quantity of sodium arsenite to one-half ounce per gallon. The greater strength killed the flies very quickly and evidently accounted for the difference in the numbers of dead flies around the pans. Repeated observations showed that the stronger solution pans contained or had around them double the number of dead adults and where two pans, one containing the standard solution of ¼ oz. per gallon and the other ½ oz. per gallon, the flies settled two to one on the stronger solution pan. As the cost of sodium arsenite was only 65 cents per pound the increased cost was only very slight per acre, and growers insist that the stronger solution is preferable.

It would appear from the past two seasons' observations that straw or excelsior in the pans offers a better landing for the flies to sip the liquid than small chips of wood which become waterlogged. The question of the amount of time required to fill the pans with liquid was checked up at each field and very little difference was noted in the quantities used by each grower or the time required to fill them.

Growers came in from other districts to see the work and many more tried out the pan system with success. It seems advisable to set the pans earlier on the sandy loam than on the cooler clay soils and growers seemed uncertain as to the exact time to set out the pans due to the weather conditions. The loss in treated plots at the College was 1.5% and .8%, while the untreated plot showed fully 25% injury by the 20th of June.

The untreated field lying between the two different fields treated by Messrs. J. J. and M. McEvoy showed a 40% loss due to maggot as in some patches practically every plant had several maggots in the bulb. One field of Mr. J. J. McEvoy's onions showed losses due to the onion smut (*Urocystis cepulae*) for all it was treated with the formaldehyde drip when sowing, the quantity applied was too small to be effective. This work will be carried out again during seeding in 1923 and six hundred to seven hundred gallons applied per acre.

The planting of trap crop onions in the rows where the pans will later be placed was the outstanding success of the season's work as the old bulbs used produced large soft tops, which were very much larger than the seedlings and attracted the adult flies. These trap plants were later pulled and destroyed and in all cases the larvae were found infesting the stalk. The trap crop not only attracted the flies to the pans, but also carried a large number of the eggs which would have been deposited on the young seedlings.

Many more growers affected with this pest will carry out control measures in 1923, as already two gardeners in Richmond have asked for information and assistance. These men have given up trying to produce this crop due to their heavy annual losses. The work therefore appears to have been profitable and successful and should be extended in 1923.

EXPERIMENTS IN THE CONTROL OF OAT SMUT.

B. T. Dickson, R. Summerby, and J. G. Coulson.

The chief grain crop in the province of Quebec is oats, and consequently the control of oat smuts is of the utmost importance. The ideal method would be to use absolutely clean seed, but since this is not commnoly possible at present, it is necessary to disinfect the available grain by some means. The usual methods of doing this are those involving the use of formaldehyde either in a concentrated form i. e. equal parts of commercial formalin and water sprayed thoroughly (so-called "Dry Method") or by soaking in, or thoroughly sprinkling with, formalin 1 pint in 320 pints of water. The latter method is safe and gives excellent control, but since it requires considerable time, the handling of quantities of water and formalin, and since it causes swelling of the grain, etc. many farmers do not practise disinfection. If therefore a simpler method can be used it may become more popular.

In this connection considerable work has been done in Australia with stinking smut or bunt of wheat. In 1917 Darnell-Smith (Agr. Gaz. New South Wales 28: 185-189, 1917) reported good control by the use of copper carbonate dust and again in 1919 Darnell-Smith and Ross (Agr. Gaz. New South Wales 32: 685-692, 1919) reported good results. The trials were repeated on this continent in California by Mackie and Briggs in 1920 (Science N. S. 52: 540-541, 1920) and again in 1921 (Phytopath. 11: 38-39, 1921). In 1921 Lambert and Bailey (Phytopath. 12: 36, 1922) confirmed the work of previous investigators and further showed the use of copper carbonate dust in controlling oat smuts.

As a result of this and other work not mentioned here it was decided that a project testing the use of copper carbonate among other disinfectants was worth while and the Crop Protection Institute appointed a committee to organize such a project. Among representative American and Canadian Institutions, Macdonald College was asked to co-operate through the first named author of this paper. Land, seed and labour were provided through the courtesy and co-operation of Prof. R. Summerby of the Agronomy Dept. and Mr. J. G. Coulson, M. A., made soil moisture tests and careful percentage counts during the season. All three authors co-operated in the planning and treatment.

Grain used.

Banner and Hull-less No. 709 MC oats of good average quality were used in the tests. The lots of grain were thoroughly shaken with viable spores of loose smut so that each grain carried a heavy spore load. That this is the case

is shown by the check plots of Hull-less, which had an average of 49 per cent of infected heads.

Treatments.

1. Hull-less No. 709 M. C.

(a) Formaldehyde sprinkle. The grain was sprinkled with a solution of formalin 1 pint in 320 pints of water and covered for four hours.

(b) Formaldehyde spray. The grain was sprayed with a solution of formalin 1 pint in 1 pint of water and covered.

(c) Copper carbonate dust. The grain was thoroughly shaken in a closed container, with copper carbonate dust used at the rate of 2 oz. per bushel. Thorough shaking is essential in order to make sure that such grain is well covered with copper carbonate dust.

(d) Dehydrated copper sulphate and lime dust. The treatment was similar to that in (c) and the dust used at the same rate.

(e) Copper sulphate dip. Grain was soaked ten minutes in a solution of 1 lb. copper sulphate crystals and 1 lb. of common salt in 5 gallons of water, and then for ten minutes in milk of lime (1 lb. of quicklime slaked and made up to 10 gallons by adding water).

2. Banner Oats.

Treatment with copper carbonate dust was the only one used with Banner Oats.

Germination tests.—Germination tests were made immediately after treatment, with percentages on the ninth day as below.

Variety	Treatment	Percentage of germination
Banner Dery	Check	94
Banner Dery	Copper Carbonate, dust	91
Hull-less No. 709 MC	Dehydrated Copper Sulphate and lime	89
" "	Copper Sulphate dip	83
" "	Formaldehyde sprinkle	65
" "	Formaldehyde spray	23
" "	Copper Carbonate dust	90
" "	Check	80
" "	Check	84

Date, etc.—The grain was treated on May 12th and sown on May 16th-At seeding soil samples were taken from various places in the plots and mois ture contents measured. The results are given in the below table.

Plot number	0	1	2	3	4	5	6	7	8
Moisture percentage.....	20.75	20.80	19.0	19.90	19 .50	19.83	19.50	19.67	19.70

These percentages vary little and are such as give excellent spore germination.

The weather was fine and warm and continued so till harvest, except for a rather rainy week in July.

The seedlings emerged on May 24th, headed from July 17 to 19th, and ripened on August 11 for Hull-less and August for 16th for Banner.

Smut Counts.

Careful counts of smutted heads were made on August 4 with results as shown in the following table.

Plot	Treatment	Variety	No. of smutted heads	Percentage of smut
0................	Check......................	Banner........	151	1.5
1................	Copper carb. dust.	Banner........	12	0
2................	Check......................	Hull-less.......	....	59.0
3................	Copper sulph. dip.............	"	9	0
4................	Formaldehyde sprinkle........	"	110	1
5................	Formaldehyde spray..........	"	36	0.3
6................	Copper carb. dust.............	"	41	0.3
7................	Copper sulph. li me dust........	"	27	0.25
8................	Check......................	"	....	39.3

In plots No. 0, 1, 4, 5, 6, 7, and 8 the number of smutted heads was counted carefully by two individuals on August 4th.

Size of Plots and Replications.

Owing to the act that plans had already been laid for the season's work, it was impossible to obtain the use of much land. Hence the plots could not be replicated. They were one-hundredth acre each in extent.

Consideration of Results.

As was to be expected the germination of Hull-less oats was materially reduced by the formaldehyde treatments. It appears, however, that the copper carbonate and copper sulphate—lime treatments stimulated germination. This statement is made advisedly since more tests should be carried out to dettermine actually if there is stimulation.

In the control of smut both copper sulphate—lime dust and copper carbonate dust were as effective as the formaldehyde spray within the limits of the experiment.

A STUDY OF SOFT ROT OF IRIS.

By J. K. Richardson, B.S.A., M.Sc.

Introduction.

An important horticultural crop is the Iris of which some two hundred and fifty varieties have been grown at Macdonald College. Of these, approximately one hundred and twenty varieties have died out as a result of disease during the last five years. So far as the writer can ascertain, this loss has been mainly due to "Soft rot" of the plants. Such a soft rot has been described in Europe by Van Hall (10) and a rhizome rot is mentioned by Howitt (5) in Canada. It is the aim of the writer to show by this investigation the cause of Iris soft rot in Quebec, to study the pathological histology and, if possible, to compare the causal organism with that described by Van Hall.

Hosts.

Bacterial soft rots are prevalent in all parts of the country, and the disease occurs on a wide variety of hosts. Erwin F. Smith (9) reports the disease of cabbage, cauliflower, turnip, parsley, celery, lettuce, callalily, radish, cucumber, musk-melon, potato, tomato, pepper, eggplant, hyacinth, onion, rutabaga, and salsify. He also states that in all these cases, with the exception of the last two, rutabaga and salsify, *Bacillus Carotovorus* has been isolated in pure culture.

Howitt (5) gives a similar list of soft rots caused by *Bacillus Carotovorus* but he adds that it also causes a soft rot of the German Iris. It is possible that other authors have mentioned this disease, but the writer has not been able to find other citations.

History and geographical distribution.

The knowledge of the history and geographical distribution of this disease is comparatively vague. The first report of the Bacterial Rhizome Rot of Iris is that of Van Hall, who found specimens of the disease at Sassenheim, in Holland, in the year 1901. He investigated it and described it rather fully in his publication of 1903 (10). During the years directly following this discovery, the disease was found in various parts of the United States by both E. F. smith and L. R. Jones. They, however, did not investigate the disease, since at the time they were working on the soft rots of vegetables, principally the cabbage and the carrot. The organism causing these rots was isolated by them and described as *Bacillus Carotovorus.* The present writer has been unable to obtain any literature in which either of these workers made special studies of the soft rot of the Iris, but Smith (9) states that the disease is caused by the same (or a similar) organism as the one causing the soft rot of cabbage, namely, *Bacillus Carotovorus*

The writer has found that the disease is present at, and in the vicinity of, Macdonald College, the city of Montreal, and around London and Toronto in Ontario.

Investigations tend to show that the soft rot of the Iris rhizomes resembles very closely the rot of the cabbage, turnip, and other vegetables, not only in the effect on the host, but also in the nature of the causal organism. Since the bacterial soft rot of vegetables has been reported from practically all places where the host plants are cultivated, and since the climatic conditions which favour the growth of these vegetables are also very similar to, and sometimes identical with those in which the Iris thrives, it is not at all improbable that wherever soft rot of vegetables is found the bacterial soft rot of the Iris will also occur.

Eonomic importance.

Members of the genus Iris are important commercial plants used for both outside decorative purposes and also in the cut flower industry, but the first mentioned purpose is the more important. There are two types of Iris, the one with and the other without a rootstock or rhizome. The type having the rhizome, although it is of less commercial value than the latter type, is by far the more popular on account of the extreme ease with which it can be cultivated .

The rhizome type of Iris is not an important host for fungus parasites, and the growers lay very little stress on the damage they cause. The bacterial rhizome rot, however, has been becoming more serious in recent years.

As has been already stated, in the year 1901 and 1902 the disease was extremely bad among the Iris plantations in Holland and caused extremely heavy losses to the growers especially in the vicinity of Sassenhem. This is the only report of the disease having occurred in Europe. A thorough search through the literature has given the writer very little information on the economic importance of the disease in this country. It is nevertheless present, because, in various publications, such as E. F. Smith (9) and J. E. Howitt (5), it has been mentioned that there is a bacterial disease which causes the rotting of the Iris rhizomes.

The writer's investigations have shown this disease to be of considerable economic importance to growers, both in Quebec and Ontario. A few years ago, Mr. T. G. Bunting, Professor of Horticulture at Macdonald College, obtained a large number of different varieties of Iris, to be used for decorative purposes around the College campus. The original collection of two hundred and fifty different varieties has been reduced to eighty by the ravages of this bacterial disease during the past five years. Large numbers of infected plants have also been found in the immediate vicinity of Montreal. Often they were completely destroyed by the disease, thus rendering them useless for decorative purposes and a menace to the surrounding plants which are susceptible to the same pathogen.

In the summer of 1921, the writer, on corresponding with Professor Howitt of the Ontario Agricultural College at Guelph, was able to obtain the names of two men, namely C. E. German, of London, Ontario, and C. R. C. Clarkson, of Toronto, Ont., who had been seeking information from him regarding the rot in question. Communication with these two men brought to light the fact that in their respective districts the soft rot of Iris was causing considerable loss to many growers, owing to the destruction of valuable specimens.

In the light of the above facts, there can be very little dobt that the bacterial soft rot of Iris is a disease of considerable economic importance. It is true that the districts from which it has been reported are not extremely numerous but that is no proof that the disease is not widespread. The reason why so little stress has beeen laid on the disease is because those who grow Iris plants in large numbers are not very numerous, and when small growers lose and occasional specimen comparatively little attention is paid to the matter.

Symptoms of the disease.

As far as the writer has been able to observe, the infection and rotting of parts of the plants make take place at any time during the growing season whenever conditions are favourable for the growth of the parasite. Specimens of newly infected shoots were collected from early spring until as late as October 9th.

The disease is first noticeable in the field by the presence of leaves with wilted tips. A closer examination of the shoots shows that they are slightly dwarfed as compared with the healthy parts of the plant. Conditions made it impossible to obtain an illustration of this fact from plants growing in the field. The writer, however, transplanted both diseased and healthy shoots from the same plants, and after placing them in the greenhouse under the same conditions, watched their development. After five months the diseased plant was extremely dwarfed while the healthy specimen appeared quite normal.

After the tips of the leaves die back, the basal portions commence to show watersoaked areas. This watersoaking, which is due to the breaking down of the cells, progresses up the leaf until the latter becomes limp and collapses. The disease spreads from the centre of first infected shoot, upwards, until finally, after a period of from 7 to 10 days from when the first symptoms are noticed, the entire shoot becomes wilted. After the leaves have collapsed, there is often a bacterialooze of a dirty cream colour, which exudes from the base of the shoot just above the ground. Once the shoot has become wilted, it is only a short time till it becomes dried, turns brown, and entirely shrivels up.

In the greenhouse, when plants are kept under bell jars and then artifically inoculated, the symptoms are slightly different, due to the fact that the rotting takes place much more rapidly. In one case an artificially inoculated plant which was growing in sterile sand became entirely wilted for days after inoculation. In a case such as this, there is no apparent dwarfing or wilting of the leaf tips, otherwise the appearance of the disease is similar to that in the field.

In the rhizome the first visible sign is a slight darkened area around the point of infection. This gradually increases until the entire young part of the rhizome has become infected. An examination of the infected part will show the rhizome tissues to be soft and of a thick slimy consistency, as compared with the firm turgid condition of the normal tissue. In a short time the whole infected part will be reduced to a soft, slimy, dirty-gray mass, swarming with the bacteria and emitting a stong unpleasant odour. As the disease progresses in the rhizome, this soft rotten mass gradually loses its moist consistency, be-

coming dry and having a somewhat granular appearance. Althogh the entire central part of the rhizome is totally disintegrated, the tough epidermis remains comparatively unchanged.

The most advanced stages of the disease are characterized by a dead shoot, at the base of which is found a badly affected rhizome. The younger parts are reduced to a dark brown granular mass, with a musty odour, which can be easily separated from the remainder of the rhizome.

Observations show that the infection is rather local in the plant, and not transmitted from one part to another through the rhizome. Unless the weather is extremely favourable, only infected shoots succumb to the disease, the remainder of the plant remaining unaffected. It is the opinion of the writer that the disease is transmitted from one shoot to another through the intervening soil. This was proved by the examination of plants with diseased and healthy shoots, which showed that the only infection that occurred to the healthy shoots was an occasional wilting of their outer leaves, indicating that the pathogen travelled through the soil and not through the rhizome.

Etiology.

Isolation of Organisms.

The writer obtained in pure culture thirty-two organisms from soft rot lesions of different plants. Of these twenty were from Iris, six from turnip, four from cabbage, and two from onion.

In addition, pure cultures of *Bacillus carotovorus* from Wisconsin and Ontario Agricultural Colleges, were placed at the writer's disposal.

The standard technique was used in the isolation of the pathogens from diseased tissues. Young newly infected parts were thoroughly disinfected, then small particles of the inner tissue removed to sterile water blanks from which plates were poured. After the incubation of these plates, cultures were made from individual colonies. In no case were there more than two different types of colonies on the same plate. In cases where there were more than one, each was isolated separately and labelled with an additional a, or b, after the original culture number.

The medium used in all cases was a 2% Iris leaf infusion agar made up according to the following formula:—

Iris leaf infusion	500 c.c.
Dextrose	20 gms.
Agar	20 gms.
Distilled water	500 c.c.

Field Inoculations.

On August 8th, 1921, some twenty-five pure cultures were transferred to agar slants and incubated at 7°C for twenty-four hours. The cultures were then taken to Montreal where they were used for the artificial inoculation of some wild Iris plants which had been located at the edge of a swamp in the outskirts of the city. The inoculations were made by needle pricks in the base of the stem just below the surface of the ground. These operations were carried out late in the afternoon, so as to give the organisms the best possible chance of becoming established before they became affected by the intense heat of the sun during the day. The inoculated plants were carefully observed every day for two weeks and twice during the third week. At the end of this period, no visit ble infections were observed.

On August 16th., day-old cultures were obtained from the twenty-five organisms mentioned above, and inoculated in the same manner as above into cultivated Iris plans on the College campus. These inoculations were observed to regular intervals of two days for three consecutive weeks. At the end of this period, nothing but negative results were obtained.

The writer is unable to explain the reason for these negative results, but it was probably due to the dry environmental conditions which prevailed at the time of inoculation. Although the wild plants were located in a damp field, the entire three weeks during which the observations were taken were extremely dry, there being only one slight shower during the period. Similar conditions also existed after the cultivated plants had been inoculated. Although the inoculations were made late in the afternoon to give the organisms the bes-possible conditions to produce infection, it is not at all unlikely that the dry heat of the ensuing days inhibited their pathogenic action and finally killed them entirely.

Tansplanting.

Before the ground was frozen in the fall of 1921, some four dozen plants were removed from the field and planted into five inch pots with good greenhouse soil. Half of these plants were placed in cold storage and the remainder were placed in the greenhouse where the temperature ranged from 65°-70°F These latter plants were given a month in which to become established before inoculations were made.

Petri Plate Cultures.

To test the pathogenicity of the isolated organisms before trying to infect the Iris plants in the greenhouse, inoculations with all the organisms were made on slices of raw yellow carrot and also slices of Iris rhizomes. The medium to be used was cut into slices about ¼ inch thick and washed thoroughly in distilled

water, then in mercury bichloride 1: 1000, and afterwards rinsed twice in sterile water to remove all traces of the mercuric chloride. These slices were then placed in sterile petri plates ready for inoculation. In the bottom of each plate there was placed a piece of sterile filter paper, which was kept moist with sterile water while the cultures were under observation.

Carrot inoculations.

The carrot plugs were inoculated on October 28th from agar slope culture thirty-six hours old. The inoculum was placed on the surface of the plug which was then gently pricked with a sharp sterile needle to give the bacteria access to the normal tissues, in case some of the exterior cells had been killed by the mercuric chloride. After inoculation the plugs were incubated at 27oC.

At the end of the third day the cultures were examined with the following results;—1a and 3a showed considerable bacterial growth on the surface of the plug, 4, 7a and 10 showed slight growth, 26b showed considerable growth and apparently slight rotting, and 19b showed growth over the entire surface of the plug and also in the liquid in the bottom of the petri plate, but there was practically no appearance of rot. The remaining slices showed absolutely no signs of infection whatever and could not be distinguished from the check cultures.

After five days the results were slightly more pronounced. In all cases the infections described above were somewhat increased and in addition 15 showed slight bacterial growth on the surface of the plug.

In all cases where infection had been obtained, isolations were made to agar slants and labelled with the letter "C" after the organism that had caused the ot. Thus, for example, the organism which had been isolated from the rot caused by "4" was labelled "4C" and so on with all cases.

Iris Plug Inoculatons.

On November 16th, slices of Iris rhizomes were inoculated in a similar manner with forty-eight hour old cultures of all the original organisms and also the organisms that had been isolated from the infected carrots. These were incubated at 27oC, and after two days the following results were recorded;— 2, 3aC, 7a, 7aC, and 26bC showed definite signs of rotting of the rhizome tissues while 4C, 15, and 15C showed only slight rotting. As the time increased there was no change except that the rotting gradually increased and that the plug inoculated with 7aC showed a definite increasing pink colour.

As was done with the carrot inoculations, isolations were taken from the various rots produced and the letter "I" placed after the symbol of the original infecting organi m.

Greenhouse inoculations.

Van Hall (10) states that artificial infection can be easily produced by inoculating the pathogen into the base of the stem by means of needle pricks through the epidermis. He does not state on what medium the cultures were grown or how old they were when used for inoculation. He states, however, that after cultures have been carried on artificial media for a few months they lose their virulence and are unable to cause infection of the Iris tissues.

On December 5th., after the plants in the greenhouse had become well established, they were inoculated with two-day old cultures grown on Iris leaf infusion agar. The plants were inoculated by needle pricks at the base of the shoots and the placed under glass bell jars to keep them moist and at a fairly even temperature. After four days plants 15 and 19b showed slight traces of rotting around the points of inoculation. Two weeks after inoculation 2, 3a, 4CI, 4, 15, 15C, 15I, and 26bC showed nothing but a very slight rotting at the inoculated points. The infection from 19b had increased till one leaf had entirely rotted and the rhizome at the leaf base had just commenced to decay. Once the disease had reached this stage nothing further developed. An isolation was taken from the diseased leaf, labelled 19bG and used later for inoculation purposes.

Since practically no results had been obtained from the first series of inoculations, the writer decided to work only with the organisms that had caused the rotting of the sliced Iris rhizomes in the petri plates, as these would be the most likely disease producers.

On January 13th., seven plants were inoculated with one-day old been broth cultures of organisms laC, 4, 7a, 10, 15, 19bG, and 26b, and placed in the greenhouse under bell jars.. After two weeks no visible sign of infection had appeared, so the series was discarded and negative results recorded.

As no definite posite results had been obtained with either beef broth or agar cultures, it was thought advisable to use some other medium to see if be - ter results could be obtained.

On February 8th., plants were inoculated with cultures 1a, laC, 1bC, Ca3, 4, 4C, 4C1, 7aI, 15, 5C, 19b, 26b, and 26bC, which had been prepared in the following way;—Original agar slope cultures were taken and transfers made from them to beef broth tubes. These tubes were incubated at 27°C for twenty four hours and then 1 c.c. of this bacterial suspension in the beef broth was transferred to 10 c.c. of a sterile 2% dextrose solution. The final culture was incubated for twenty -four hours and then used for the inoculation. The plants were inoculated by pouring the cultures at the base of the shoots and at the same time pricking the tissues with a sharp sterile needle. The plants thus ino-

culated were as before placed under bell jars in the greenhouse at a temperature ranging from 65°.70°F. (18°—22°C).

Eight days after inoculation, several plants, namely, 1bC, 7aI, 15C, and 19b showed definite signs of infection, the outer leaf blade in all cases being definitely watersoaked. At the end of twelve days no increase in infection was noted, except that 7aI had developed so as to exhibit definite symptoms of the disease, one shoot being entirely wilted. From an infected leaf of the above plant six re-isolations were taken and labelled 71-76. These re-isolations were made to agar slants, allowed to grow for one day at 27°C, then plates were poured and sngle colony pure cultures obtained. On February 24th., plants were inoculated with one-day old beef broth cultures of the organisms 71-76 inclusive in the same manner as previously described. Four days after inoculation definite symptoms were visible on plants 72 and 74. After four weeks the entire plants had become diseased. On March 3rd., seven days after inoculation, plants 73 and 75 also showed definite symptoms of the disease. Besides the usual watersoaking of the leaves, plant 73 showed a dark gray bacterial ooze exuding from the base of the infected shoot.

On March 10th., plants were again inoculated with twenty-four hour old beef broth cultures of organisms 1aC, 4, 10, 15C, 19b and 26b. After four day 19b showed definite symptoms of the disease. After seventeen days the plans had become entirely diseased and almost totally wilted. From young newlt infected leaves of this plant, five re-isolations were taken and numbered consey cutively from 191-195. The poured plate method was used to obtain pure-cultures, after which the organisms were used for re-inoculation purposes.

As a final test for the pathogenicity of the organisms, it was decided to try inoculations on plants which had been grown under absolutely sterile conditions. The sterile plants were obtained in the following manner; Iris plants about twelve inches high were taken from pots growing in the greenhouse and the soil entirely removed from the roots by washing in tap water and scrubbing with a small b ush. These plants were then washed in a 1-1000 mercuric chloride solution, after which they were thoroughly rinsed in two changes of sterile water. The pots used for transplanting were four inch pots which had been thoroughly scrubbed and then soaked in mercuric chloride for ten minutes. As a soil, pure sand was used which had been previously autoclaved for two hours at eighteen pounds pressure. The sterile plants were placed in the sterilized pots which contained the sterilized sand and were then watered with sterile water, and kept till ready for inoculating.

The organisms used for inoculating were 721, 191, and 74. Agar slope cultures twenty-four hours old were used and the plants inoculated by means of needle pricks just below the surface of the sand. After inoculation the plants

were placed under bell jars and kept at 65o 70oF. The inoculations were made on April 4th., and at the end of one week all three plants showed definite disease symptoms.

Since good results had been obtained by using sterile plants for inoculation purposes, it was decided to complete Koch's rules of proof with organisms 7aI and 191 in this manner. On April 20th., the organisms were re-isolated from, the diseased plants.

The limited time available made it impossible for the writer to carry on extensive experiments to determine the natural atrium of infection under field conditions. However, in the many cases of inoculation that were tried by applying the inoculum to the base of the stem without wounding the tissues, no positive instances occurred. Smith (9) states that the most common means of infection is through wounds made in the host tissue by some mechanical means, such as insect punctures. Infections may also occur through lenticels, stomata, etc., but those through mechanical injuries are the most prevalent. The actual atrium of infection for the soft rot organism is not given, but it seems logical that the mechanical injuries at the bases of the shoots are the chief point for admitting the pathogen to the host.

Cultural Studies of the Organism.

The following account of the organism causing the soft rot of Iris is by no means exhaustive, but in the time available the writer has attempted to carry on sufficient experimental work to determine the identity of the pathogen.

The original collection of organisms was obtained from various sources during the summer of 1921 and kept growing on artificial media until used for inoculation experiments.

As has already been described, these organisms were inoculated into slices of raw carrots and also slices of healthy Iris rhozomes. The organisms which proved pathogenic were then used for the plant inoculations and 7a1 and 19b were the only ones with which the writer was able to produce definite characteristic disease symptoms. 7aI was isolated from an infected rhizome slice after inoculation with 7a, which had been previously isolated from a diseased Iris plant at the College. 19b was a pure culture of *Bacillus carotovorus* obtained from Michigan Agricultural College.

Cultures of the pathogen were re-isolated from infected plants and then checked according to the chart compiled by the Society of American Bacteriologists.

In order to eliminate any error, Koch's rules of proof were carried out with plants grown under absolutely sterile conditions. From the infected plants

which had been rotted as a result of the inoculations with 72 and 191 isolations were made, namely, 721 and 1912. These isolations were grown, pure cultures made and with them another group of sterile plants was inoculated. Within a week characteristic symptoms had appeared in both cases. Again from these diseased plants isolations 7213 and 19122 were taken. No further inoculations were required because the organisms 72 and 191 had been "proved up" on sterile Iris plants.

The following will show a comparison of the organisms studied as compared with *Bacillus carotovorus;*

B. carotovorus	B. 221.1113022
The writer's isolation......................	B. 221.1113021

From the above numbers it appears that the pathogens studied have characters which resemble very closely those of *Bacillus carotovorus* (Jones). The actual resemblance, however, as will be seen later, is not as close as these group numbers appear to show.

Detailed Study of the Organisms.

In order to simplify the following discussion where no comparisons are made, it will be taken for granted that the organisms described are similar to *Bacillus carotovorus.*

Morphology.

The organisms studied were all rods with rounded ends, varying in length from 1.3 mu.—4 mu. and in width from.5 mu.-1 mu. Thisshows very littevariation from *B. carotovorus* which averages .8 mu. 2 mu. (Marshall (7). In all cases the organisms were actively motile by means of peritrichiate flagella. No endospores or capsules were found and the presence of pseudozoogloea or involution forms was not observed. The organisms are Gram negative and very susceptible to aqueous stains.

Broth.

Growth in beef peptone broth was extremely profuse, with only a slight pellicle and abundant sediment.

Agar Slant.

Growth was glistening, smooth, somewhat spreading and with a slight gray colour.

Agar Plate.

Small circular shining colonies were produced averaging in size about one half mm.

Gelatin Stab.

There is an extremely abundant surface as well as stab growth, which is beaded to filiform in appearance. Although the group numbers show liquefaction in all cases, there is a vast difference in the cultures. The 19b derivitives show fairly rapid liquefaction of the stratiform type starting the third day and becoming complete at the end of two weeks. The 7a1 derivitives show extremely slow liquefaction, never commencing before two weeks and at the end of five weeks showing only a slight napiform appearance. With *B. Cavotovorus* however, the liquefaction is extremely rapid, being complete within six days after inoculation.

Gelatin Plate Colonies.

Colonies are small and circular, and appear somewhat wrinkled when examined under the microscope.

Potato Plugs.

The growth is fairly abundant covering almost the entire the with a grayish white growth. The medium, however, was only very slightly grayed.

Miscellaneous Features.

All organisms showed abundant growth at 37°C but 27°C appears to be the optimum temperature. In no case was there growth on Cohn's solution, but Uschinshy' solution was favourable.

Milk.

The production of an acid curd with a slow peptonization of the casein was always characteristic.

Biochemical Features.

In every case there was a production of ammonia and a reductionof nitrates, also a slight production of indol.

In conclusion, although the writer's isolated organisms have practically the same group number as *Bacillus carotovorus*, they are not identical, as can be seen by the above characteristics, principally in relation to their liquefaction of gelatin. Although the derivatives of 19b liquefy gelatin, the action is not so rapid as in the case of *B. carotovorus*, nevertheless the liquefaction cannot be

disputed. In the derivatives of 7aI there is a greater difference in that the liquefaction is so slight as to be practically negligible. In all other characteristics, however, the differences are only of minor importance.

From the above study of the two pathogens causing the soft rot of Iris, it appears to the writer that the organisms, although not identical with B. carotovorus, do not vary sufficiently from it to become new species, therefore should be considered merely as slightly different varieties of the original organism described by Jones.

Smith (9) states that *B. oleraceae* (Harrison), *B. omnivorus* (Van Hall), and *B. apivorus* (Wormold) are apparently identical with *B. carotovorus* (Jones), and since the writer proved the organism causing soft rot of Iris to be a variety of *B. carotovorus*, it therefore appears that the organism causing the disease in this country is similar to that causing the disease in Europe.

Pathological Histology.

The material for this study was taken from various parts of the plant, both leaf and rhizome, in different stages of infection. Both naturally and artificially inoculated plants were used. The samples were killed and prepared in the usual way for microtome sectioning. The sections were in most cases stained with carbol fuchsin, but occasionally Delafield's haema toxylin was used.

Pathological Effect on the Rhizome.

The cells of healthy rhizome tissue are very uniform in size and shape. The difference in size of the cells in respective sections may be due to the fact that they are taken from plants of different varieties or from different parts of the rhizome. The cells contain large numbers of starch grains, the protoplasm being almost entirely hidden except for the very distinct nuclei.

The progress of the disease in the rhizome is extremely rapid and, therefore, the writer was unable to obtain good specimens of the primary effect of the pathogen upon the host tissues. The cell walls gradually become broken down, and the cell shape is far less definite than in the healthy tissue. The destruction of the middle lameilae and thus the separation of the cells from one another can be seen in many places. In the primary infected tissues it can also be noted that the cell contents, both starch and protoplasmic commence to disintegrate. The starch grains are fewer in number than in the healthy tissues and less regularly placed. Plasmolysis also occurs combined with a slight enlargement of the nuclei.

As the disease progresses the cell contents gradually become more plasmolyzed and disintegrated until they have practically disappeared. The last part of the cell contents to disintegrate is the nucleus, but as the disease progresses, this also becomes broken down and the whole cell contents, resemble an irre-

gular, loose, granular mass within the cell wall. Later the cell wall disintegrates until the entire tissue becomes a broken down mass, which will scarcely hold together.

The absence of bacteria in the primary stages of the disease leads the writer to believe that there is a toxine or enzyme produced by the invading bacteria which is able to cause the disintegrative effet on the host at some distance from the cells occupied by the bacteria themselves.

In many cases, while examining slides of diseased lissues, the writer observed vascular bundles which were more or less filled with a golden brown, very finely granular material. Whether or not this was due to the effect of the invading organism the writer is unable to state definitely, because all vascular bundles of diseased parts did not contain these deposits. The fact remains, however, that in no case were there any such deposits observed in the healthy rhizome tissues.

Pathological Histology of Leaves.

A definite outline of the cells and a uniformity of the structure and arrangement is typical of the healthy tissues.

The first noticeable effect of the pathogen on the leaves is a dissolution of the middle lamellae of the cells, thus allowing them to separate from one another. As the disease progresses, the cell contents become broken down. This disintegration continues fairly rapidly until the entire leaf becomes broken down and is held together only by fragments of the vascular bundles.

When the leaf tissues become watersoaked, the epidermis loosens from the remainder of the leaf tissue and can easily be removed.

The rotting is not confined to the leaf parenchyma, for the vascular system is also attacked to a considerable extent. Even although the vascular tissue is subject to the destructive influence of the pathogen, it is not so totally susceptible and does not become entirely disintegrated even in the final stages of the disease.

As was the case with the rhizome tissues, most of the damage or at least a large part of it appears to be caused by a toxic substance produced by the invading bacteria, and not by the actual presence of the pathogenic organism. As the writer's time was necessarily limited, no experiments could be carried out to prove this point. Van Hall (10, however, investigated it rather thoroughly. He took liquid cultures of the pathogen he had isolated, namely *B. omnivorus,* and filtered it so as to remove all the bacteria. The filtrate thus obtained which contained no living organisms, was used for inoculating certain Iris plants which later developed light symptoms of the disease.


1
2.
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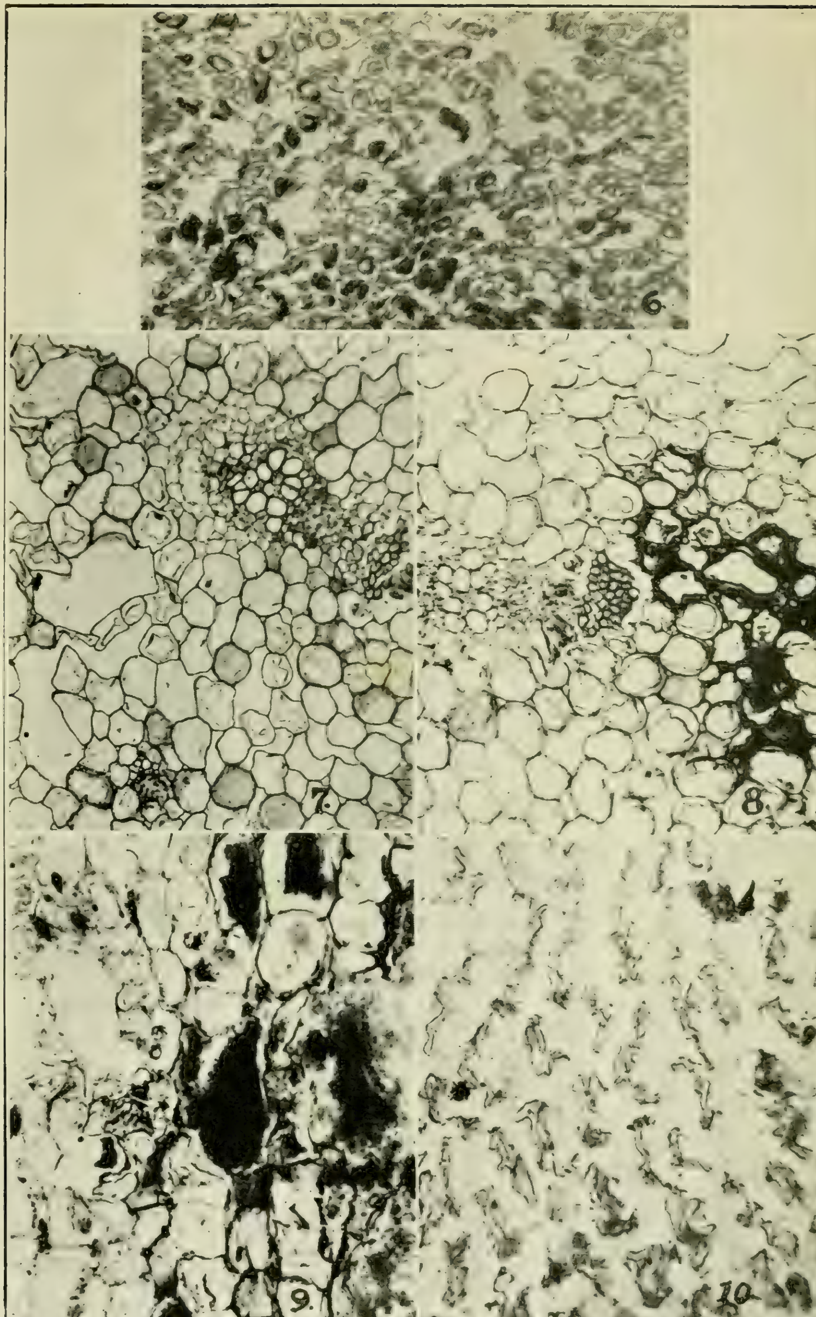
5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12.
13

The above discribed pathological histology differs from that given by Van Hall (10) in two main points;—First, he states that the starch grains are not destroyed by the invasion of the bacteria, and second that the bacteria are unable to enter the cells, that is, they are entirely intercellular. In egard to the first point, in all the diseased sections that were examined by the writer, in not a single case were the starch grains found to be intact. With regard to the second difference, the writer was able to obtain photomicrograph which definitely showed the bacteria in the cells. Whether the bacteria penetrated the wall and thus entered the lumen of the cell, or whether they entered after the wall was ruptured, the writer is not able to state. The bacteria may not enter the cell till after the wall is ruptured, but in any case it is the toxine (Van Hall (10) produced by the invading pathogen that causes the breaking down of the wall; and even if the organisms do not enter the lumen till the wall has been ruptured, the fact remains that they do enter the cell, and are, therefore not strictly intercellular.

Summary.

1. Bacterial rhizome rot of Iris is increasing in importance in this part of the country.
2. The organisms causing soft rots are parasitic on a wide range of plants.
3. The complete geographical distribution of bacterial soft rot of Iris is not known, but the disease is probably wide spread.
4. This disease is economically important on account of its destructiveness to large numbers of valuable Iris plants.
5. The disease is a typical soft rot destroying the rhizome parts attacked as well as the foliage.
6. Thirty-six organisms were isolated from various sources and different inoculation tests carried out which resulted in the obtaining of typically diseased plants by inoculation with two of the organisms used.
7. The two pathogens finally "proved up" by the writer react on various media in a similar manner to *B. Carotovorus* and are believed to be forms of that species.
8. Smith (9) states that *B. Oleraceae*, *B. omnivorus* and *B. Apivorus* are apparently identical with*B. Carotovorus*. The writers' work shows that the disease in Quebec is caused by a form of *B. Carotovorus*. If the view of Smith is correct, it appears that the disease in Quebec and in Europe is caused by similar organisms.
9. The pathogen destroys the host by a dissolution of the middle lamellae of the cells, a gradual destruction of the cell contents, and finally a total disintegration of the diseased tissues.

This article is an abridgment of a thesis taken under Dr. B. T. Dickson in the Department of Botany, Macdonald College, and submitted to the Graduate School of McGill University in partial fulfilment of the requirements for the degree of M. Sc.

The writer wishes to acknowledge his appreciation to Dr. Dickson for helpful suggestions and constructive criticism, to Dr. Hood of Macdonald College and Dr. L.-R. Jones of Wisconsin for cultures which they supplied and to Mr. J. P. Spittall for his translation of German references.

Contribution No. 20 Dept. of Botany, Macdonald College, Que.

DESCRIPTION OF PLATES.

Plate V.

FIG. 1.—The Iris plot at Macdonald College, showing misses due to plants having been killed by the disease.

FIG. 2.—The cut surface of an Iris rhizome, showing diseased and healthy tissue.

FIG. 3.—Reverse side of Fig. 2 showing very little differentiation except the collapsing of the root on the diseased part.

FIG. 4.—Photomicrograph of cross section of healthy rhizome tissue showing the starch grains intact.

FIG. 5.—Cross section of diseased rhizome tissue showing the lack of starch grains and also the bacteria within the cells.

Plate VI.

FIG. 6.—The final stage in the disintegration of a diseased rhizome.

FIG. 7.—Section through a healthy leaf.

FIG. 8.—Section of a diseased leaf showing the death of the tissues due to the invasion of the pathogen.

FIG. 9.—Diseased leaf tissue showing disorganization of cells and presence of bacteria.

FIG. 10.—The final stage in the disintegration of the leaf tissue

Plate VII.

FIG. 11.—The complete death of a plant caused by the artificial inoculation with *B. Carotovorus*.

FIG. 12.—One collapsed shoot of an infected plant showing the typical water-soaking, a characteristic early symptom.

FIG. 13.—Here is shown the complete collapsing and typical watersoaking of a plant inoculated while growing under absolutely sterile conditions.

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CORRIGENDUM.

Prof. B. T. Dickson.

On page 82 of the Fourteenth Annual Report of the Quebec Society for the Protection of Plants (1921-22) in an article concerning Potato Canker wherein is given a list of countries from which the disease has been reported, France is included.

In a letter dated February 27th, 1923, Dr. Etienne Foex, Director of the Station of Vegetable Pathology, Paris, France, states that this disease has never been found in France in spite of careful search. That it does not occur in Italy is also the belief of Dr. Foex.

I am glad to insert this corrigendum in the Fifteenth Annual Report, and trust that recipients will insert it alongside page 82 of the Fourteenth Report.

FRENCH AND ENGLISH NAMES FOR THE COMMON INSECTS OF QUEBEC.

By G. Beaulieu.

(Printed by permission of Mr. A. Gibson, Dominion Entomologist).

A

Apple aphis	Puceron du pommier
Apple curculio	Charançon de la pomme
Apple leaf skeletonizer	Pyrale de la feuille du pommier
Asparagus beetle	Criocère de l'asperge
Apple leaf hopper	Cicadelle du pommier
Armyworm	Légionnaire
Ambrosia beetle	Scolyte perceur
Ash gray blister beetle	Cantharide gris cendre
Alfalfa leaf weevil	Charançon de l'alfalfa
American cockroach	Coquerelle des caves
Apple maggot	Larve de la pomme
Angoumis grain moth	Mite angoumoise du grain
Apple twig beetle	Scolyte du pommier

B

Bean weevil	Bruche couverte
Black peach aphis	Puceron noir de la pêche
Black cutworm	Ver gris noir
Bronze birch borer	Perceur doré du bouleau
Bean leaf beetle	Chrisomêle de la feuille de haricot
Bed bug	Punaise des lits
Buffalo tree hopper	Cérèse de Buffalo
Beet leaf hopper	Cicadelle de la betterave
Black blister beetle	Cantharide noire
Brown-tail moth	Bombyx cul brun
Bee moth	Teigne des ruches
Birch sawfly	Mouche à scie du bouleau
Blackberry soft scale	Kermès de la ronce
Bronzed cutworm	Ver gris bronze
Black vine weevil	Charançon noir de la vigne
Bag worms	Chenilles à besace
Black scale	Kermès noir
Book louse	Atropos des livres
Bud moth	Ver du bourgeon
Bronze flea beetle	Puce de terre
Birch leaf mining sawfly	Mouche minière des feuilles du bouleau.
Black violet aphis	Puceron noir de la violette
Birch skeletonizer	Bucculatrix du bouleau

C

Cabbage aphis	Puceron du navet
Cabbage looper	Noctuelle des choux
Carpet beetle	Rongeur des tapis
Cherry scale	Kermès du cerisier
Corn root aphis	Puceron de la racine du maïs
Currant borer	Aegie du groseillier
Chestnut weevil	Charançon de la noisette
Clover mite	Mite du trèfle
Cowpea weevil	Bruche de chine
Catalpa sphinx	Sphinx catalpa
Cigar case bearer	Chenille porte case du pommier
Codling moth	Pyrale de la pomme
Cranberry looper	Arpenteuse de la caneberge
Currant fruit fly	Ver à groseille à grappes
Cherry leaf beetle	Galerucelle du cerisier
Clover root borer	Rongeur de la racine du trèfle
Colorado potato beetle	Chrysomèle de la pomme de terre
Cherry aphis	Puceron du cerisier
Clover cutworm	Mamestre du trèfle
Currant aphis	Puceron du raisin
Cabbage maggot	Vers des choux
Cottony maple scale	Kermès floconneux de l'érable
Carrot rust fly	Mouche de la carotte
Cabbage plusia	Plusia du choux
Cabbage worm	Chenille du choux
Cabbage pinionea	Pionea du choux
Cherry fruit maggot	Mouche du cerisier
Cecropia moth	Attaque cecropia
Carpet moth	Mite des tapis
Cankerworm	A penteuse du pommier
Clover weevil	Brûche du trèfle
Cherry or pear slug	Némate (petite livrée)
Clover seed midge	Mouche de la graine du trèfle

D

Diamond back moth	Teigne des choux
Destructive pea aphis	Puceron destructeur du pois

E

Eight spotted forester	Alypie à huit taches
European fruit scale	Kermès coquille à l'huître
Euonymus scale	Kermès euonymes
Elm borer	Saperde de l'orme
Elm woolly aphis	Puceron lanigère
Eye spotted bud moth	Pique-bouton ocellé

F

Fall webworm	Chenille à toile d'automne
Fall cankerworm	Arpenteuse de l'automne
Fuller's rose beetle	Charançon de la rose

Flat headed apple tree borer	**Ver rongeur du pommier**
Florida red scale	**Kermès rouge de Floride**
Fern scale	**Kermès des fougères**
Florida wax scale	**Kermès cire de Floride**
Fall armyworm	**Légionnaire d'automne**
Fir sawfly	**Mouche à scie du sapin**
Forest tent caterpillar	**Livrée des forêts**
Five spotted hawk moth	**Sphinx à cinq taches**
Fungus gnat	**Mycetophile du champignon**

G

Grape scale	**Kermès de la vigne**
Greedy scale	**Kermès rapace**
Greenhouse white fly	**Aleurodes des serres**
Green june beetle	**Hanneton vert**
Grass thrips	**Thrips commune de l'herbe**
Green striped maple worm	**Ver à raies vertes de l'érable**
Granary weevil	**Charançon des greniers**
Grape curculio	**Charançon de la vigne**
Green house leaf roller	**Tordeuse des feuilles des serres**
Gray blister beetle	**Cantharide grise**
Glassy cutworm	**Ver gris vitraux**
Grape flea beetle	**Altise de la vigne**
Glover's scale	**Kermès de Glover**
Grape phylloxera	**Phylloxera de la vigne**
Gipsy moth	**Bombyx disparate**
Green house leaf tyer	**Lieuse de feuille des serres**
Green clover weevil	**Charançon vert du trèfle**
Grapevine aphis	**Puceron des vignobles**
Grain aphis	**Puceron du grain**
Grape leaf hopper	**Cicadelle de la vigne**
Green fruit wo m	**Ver des fruits verts**

H

Howard's scale	**Kermès de Howard**
Honey bee	**Abeille**
Horse bot fly	**Gastrophile du cheval**
House cricket	**Grillon domestique**
Horn fly	**Mouche des cornes**
Harlequin cabbage bug	**Punaise des choux**
Hessian fly	**Mouche de hesse**
House fly	**Mouche des maisons**
Hop aphis	**Puceron du houblon**
Hemispherical scale	**Kermès hémisphérique**

I

Io moth	**Noctuelle Io**
Imported cabbage worm	**Ver exotique des choux**
Impor ed currant worm	**Ver exotique du rainin**

J	
June beetle	Hanneton-Larve du hanneton
L	
Larch case bearer	Porte case du mélèze
Larder beetle	Dermestre du lard
Lesser apple worm	Petit ver de la pomme
Lesser house fly	Petite mouche des maisons
Latrine fly	Mouche des latrines
Lesser migratory locust	Petite locuste voyageuse
Large clover weevil	Gros charançon du trèfle
Large larch sawfly	Mouche à scie du mélèze
M	
Melon caterpillar	Chenille du melon
Margined blister beetle	Cantharide marginée
Mediterranean flour moth	Papillon gris de la farine
Magnolia scale	Kermès du magnolia
Maple leaf cutter	Chenille de la feuille de l'érable
Mealy bug	Faux kermès des serres
N	
Negro bug	Punaise noire
Northern mole cricket	Hanneton du cerisier
Narcissus fly	Mouche du narcisse
O	
Oblique banded leaf roller	Cigareuse à bande obiqlue
Oyster shell scale	Kermès à coquille d'huître
Onion maggot	Ver de l'oignon
Onion thrips	Thrips de l'oignon
P	
Potato tuber moth	Teigne de la pomme de terre
Q	
Quince curculio	Charançon de l'aubépine
R	
Rose scale	Kermès de la rose
Rice weevil	Charançon du riz
Red backed cutworm	Ver gris à dos rouge
Rocky Mountain spotted fever tick	Teigne à fièvre des Mts Rocheuses
Rose sawfly	Nématode du rosier
Red turnip beetle	Barbeau rouge du navet
Raspberry webworm	Fausse chenille à tente du framboisier
Raspberry sawfly	Nématode du framboisier
Red legged locust	Sauterelle commune
Rose chaffer	Scarabie du rosier
Raspberry cane borer	Perce bois du framboisier
Red humped apple caterpillar	Charançon à bosse rouge du pommier
Round headed apple tree borer	Saperde du pommier
S	
San José scale	Kermès San José
Sinuate pear tree borer	Agile du poirier
Squash bug	Punaise de la courge
Strawberry crown moth	Aegerie du fraisier

Strawberry leaf roller	Ancylis rongeur de feuilles du fraisier
Strawberry weevil	Charançon du fraisier
Silkworms	Bombyx du murier
Scurfy scale	Kermès teigne
Spruce gall louse	Kermès de l'épinette
Striped cucumber beetle	Chrysomèle du concombre
Strawberry flea beetle	Altise de la fraise
Sugar cane beetle	Barbeau de la canne à sucre
Sheep maggot	Lucille du mouton
Spotted cutworm	Ver gris tacheté
Spotted paria	Paria tacheté
Stable fly	Mouche des étables
Squash lady beetle	Coccinelle boréale
Striped blister beetle	Cantharide barrée
Strawberry crown borer	Perce collet fraisier
Spruce budworm	Ver du bourgeon de l'épinette
Shot borer	Xylebore
Spring tail (Collembola)	Colembale

T

Ticks	Teignes
Tobacco flea beetle	Altise du tabac
Tarnished plant bug	Punaise terne
Tent caterpillar	Livrée
Two-striped locust	Locuste à deux bandes
Tomato worm	Ver de la tomate
Turkey gnat	Mouche noire meridionale

V

Virginian anista	Anistade Virginie
Variable cutworm	Ver gris variable
Variegated cutworm	Ver gris panaché

W

Willow leaf beetle	Galerucelle du saule
Wheat stem maggot	Mouche à scie du chaume de blé
White line sphinx	Sphinx à ligne blanche
Walnut sphinx	Sphinx du noyer
White cedar twig borer	Perce rameau du cèdre blanc
West Indian peach scale	Kermès de la pêche des Antilles
Walnut scale	Kermès du noyer
Warble fly	Hypoderme rayée-oestre du bœuf
White marked Tussock moth	Hemerocampe marquée de blanc
Wheat stem maggot	Ver du chaume de blé
Woolly apple aphis	Puceron lanigère
Weevil	Curculion or Charançon

Y

Yellow headed cranberry worm	Acleris de la canneberge

Z

Zebra caterpillar	Chenille zébrée

ABSTRACTS OF CANADIAN PLANT PATHOLOGICAL LITERATURE.

A. W. McCallum.

The abstracts and references given herewith include the papers on plant pathology published in Canada during 1922.

Anonymous. Plant diseases. 44th Ann. Rept. Ont. Agric. Coll. and Exp. Farm for 1918: 19-24. 1919.—Notes on some of the common diseases met with during the season.

Anomymous. Plant diseases. 45th Ann. Rept. Ont. Agric. Coll. and Exp. Farm for 1919: 36-41. 1920.—Mentions three diseases not noted previously.

Anonymous. Plant diseases. 46th Ann. Rept. Ont. Agric. Coll. and Exp. Farm for 1920: 17-19. 1921.
Mention is made of leaf scorch of strawberry caused by "Mollisia earlianna (E and E) Sacc., potato diseases, and the dry formaldehyde treatment for oat smut.

Anonymous. Interim Report. Ann. Rept. Division of Botany, Dom. Exp. Farms for 1920—1921. 1—108. 17 fig. 1921.—This report covers a period of five years during which no data was published owing to economic reasons. Attention is called to sections on the potato inspection service, forest pathology, investigations on common scab of potato, leaf curl and mosaic of raspberries, nature of susceptibility, and cereal rusts. Progress upon the various experiments being carried on at the field laboratories is reported.

Anonymous. Plant diseases. Ann. Rept. Min. Agric. Ont. for 1920-1921 16—20. 1922.

Anonymous. Plant diseases. 47th Ann. Rept. Ont. Agric. Coll. and Exp. Farm for 1921: 34—39. 1922.—Notes on various plant diseases including late blight of celery, oat smut, and streak of tomatoes.

Archibald, E. S. Report of the Acting Dominion Botanist. Ann. Rept. Dom. Exp. Farms foi 1919—1920:

Blair, R. J. Cause and Prevention of Decay in Structural Timber. Paper Trade Jour. Dec. 22: 51. 1921.

Blair, R. J. and E. P. Cameron. The Use of Clean Water as a Preservative for storing Mechanical Pulp. Pulp and Paper Mag. 20: 64. 1922; Paper Industry 3: 1528. 1922; Paper Trade Jour. March 2: 47. 1922; Proc. and Trans. Can. Pulp and Paper Assoc. (Tech. Sect.) for 1921-1922: 103. 1922.

Blair, R. J. Molding of Chemical Wood Pulp with Suggestions as to Methods of Control. Pulp and Paper Mag. 20: 429. 1922.

Blair, R. J. Chemical Wood Pulp is attacked by Molds. 14th Ann. Rept Que. Soc. Prot. Plants for 1921—1922: 39—41. Fig. 1—3. 1922.

Dickson, B. T. Diseases of the Potato. Sci. Agric. 2: 202-206. Fig. 10. 1922.—A recapitulation of present knowledge concerning canker, leak, and late blight.

Dickson, B. T. Diseases of the Potato. Sci. Agric. 2: 234-236. Fig. 11-12. 1922.—Notes on a stalk disease caused by "Sclerotinia sp." and on little potato caused by "Corticium vagum "B. and C. var. "solani" Burt.

Dickson, B. T. Diseases of the Potato. Sci. Agric. 2: 310-312. 1922.—Early blight, fusariose, common scab, skin spot, and silver scurf are treated briefly.

Dickson, B. T. Diseases of the Potato. Sci. Agric. 2: 325-327. Fig. 13-14 1922.—Notes on dry rot, net necrosis, and black dot disease. This latter is apparently due to "Vermicularia varians."

Dickson, B. T. Diseases of the Potato. Sci. Agric. 2: 417-419. 1922.—Brief notes on various physiological troubles.

Dickson, B. T. Plant diseases of 1921 in Quebec. 14th Ann. Rept. Que. Soc. Prot. Plants for 1921—1922: 52-58 Fig. 1-8. 1922.

Dickson, B. T Diseases of the Potato. 14th Ann. Rept. Que. Soc. Prot. Plants for 1922-1922: 67-105. Fig. 1-12. 1922.

Dickson, B. T. Studies Concerning Mosaic Diseases. Macdonald Coll. Tech. Bull. No. 1-125. Pl. 1-2: 1922—A very comprehensive list of plants known to be affected by mosaic is given The pathological histology of a large number of various species of plants affected with mosaic has been studied and numerous histological features are found to be common to all The effect of coloured light on tobacco mosaic and the effect of coloured light, sunlight, darkness, and freezing on the expressed juice of tobacco mosaic plants was studied. Mosaic was found to be transmitted by aphids and seed inheritance was established for several species.

Eastham, J. W. Report of Provincial Plant Pathologist, Vancouver. 16th Ann. Rept. B. C. Dept. Agric. for 1921: 64-69. 1922.—Three diseases not noticed previously were observed during the year. These were clover wilt "(Sclerotinia trifoliorum)," buck-eye rot of tomato ("Phytophthora terrestria)", and blister rust of white pine ("Cronartium ribicola).

Faull, J. H. Forest Pathology: In Report of Forestry Branch, 1921. Ann. Rept. Min. Lands and Forests, Ont. for 1910-1921: 259-266. Fig. 1-4. 1922. —Observations were continued upon white pine needle blight in the Temagami Forest Reserve and these confirmed previous conclusions which had been drawn in regard to this disease. The reddening of the leaves is due to the death of the absorbing roots which, in turn, is ascribed to a drying-out process that occurs in shallow soils in periods of drought.. It is probable that other tree species are affected in a similar manner.—A general investigation of butt rots of conifers is being carried on. In this work a root and butt rot of spruce, hemlock, and white pine has been observed for the first time. With this decay, which is of the type caused by Trametes pini, a stalked polypore, 'Polyporus tomentosus," is constantly associated. A preliminary account of the true tinder fungus "(Fomes fomentarious)" is given in which it is recorded that instead of causing a sap rot as commonly supposed this fungus seems invariably to commence work in the heartwood of its hosts—Poplar canker ("Dothichiza populea)" has been observed near Toronto causing much damage to a plantation of Lombardy poplars.

Faull, J. H. Forest Pathology in Relation to Forest Conservation. 14th Ann. Rept. Que. Soc. Prot. Plants for 1921-1922] 14-22. Fig. 1-5. 1922.

Grisdale, J.-H. Report of the Acting Dominion Botanist. Ann. Rept. Dom. Exp. Farms for 1918-1919: 57-61 1920.

Gussow, H. T. Report of the Dominion Botanist. Ann. Rept. Div. of Bot. any, Dom. Exp. Farms for 1921-1922: 1-73 3 Fig 1922—The annual report of the Division of Botany containing accounts of the various phases of investigative work carried on at the central and field laboratories Attention is drawn to the sections dealing with potato inspection and certification, forest pathology, leaf curl and mosaic of raspberries, and cereal rusts.

Jackson, V. W., J. F. Higham and F. W. Bradbrooke. Control of Tagged Wheat. Man. Agric. Ext. News 2: 2. 1922.

Lachaine, O. W. Sclerotial Disease of the Potato. 14th Ann. Rept. Que. Soc. Prot Plants for 1921-1922: 105-109. Fig. 1-6 1922

Major, T.-G. An Alternaria Disease of Polypodium. 14th Ann. Rept. Que. Soc. Prot. Plants for 1921-1922: 59-61. 1 fig. 1922.—A new species of "Alternaria (A. polypodii) occurring on greenhouse ferns is described and its pathogenicity demonstrated.

McCallum, A. W. Abstracts of Canadian Plant Pathological Literature. 14th Ann. Rept. Que. Soc. Prot. Plants for 1921-1922: 110-115 1922.

Newton, Margaret. Studies in Wheat Stem Rust. "(Puccinia Graminis Tritici) Trans. Roy. Soc. Can. (3rd series, section 5). 16: 153-210. Text fig. 1-3, pl. 1-6 1922—Fourteen biologic forms of wheat stem rust have been shown to be present in Western Canada and their distribution is provisionally given. All of these forms also occur in the United States—Invariably, infection was found to occur by way of the stomata after an appressorium had been formed The susceptible host adjusts itself readily to the presence of the parasite but in the resistant species the hyphae sent out by the sub-stomatal vesicles soon die The suggestion is made that the failure of the fungus to establish itself in a résistant plant may be due to starvation caused by the death of the local host cells.

Tice, C. Seed Potato Inspection and Certification in British Columbia. Sci. Agric. 2: 249-251. 1922.

White, E. W Apple Tree Anthracnose or Black Spot Canker Control. Sci. Agric. 2: 186-191. Fig. 1-3. 1922.—The results of co-operative experiments extending over a number of years indicate that anthracnose which is very prevalent and destructive in the coastal region of British Columbia can be controlled by systematic spraying with Bordeaux.

CONTENTS

SIXTEENTH ANNUAL REPORT

OF THE

Quebec Society for the Protection of Plants

1923 - 1924

Supplement to the report of the Minister of Agriculture

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QUEBEC

SIXTEENTH ANNUAL REPORT

OF THE

Quebec Society for the Protection of Plants

1923-1924

Supplement to the report of the Minister of Agriculture

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To the Honourable J. E. Caron, M.P.P.,

Minister of Agriculture,

Quebec.

Sir :—

I have the honour to present herewith the sixteenth Annual Report of the Quebec Society for the Protection of Plants, containing the proceedings of the winter meeting of the Society, which was held at Macdonald College, Ste. Anne de Bellevue, Que., on Wednesday, April 23rd, 1924.

Included are the papers that were read, and the reports of the officers of the Society.

I have the honour to be,

Sir,

Your obedient servant,

E. MELVILLE DUPORTE,

Secretary-Treasurer.

Macdonald College, Quebec.

QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS.

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Auditor—J. C. Coulson, Esq., Macdonald College.

Delegates to the Royal Society of Canada.—Prof. W. Lochhead and Dr B. T. Dickson, Macdonald College.

Delegates to the Ontario Entomological Society.—Prof. Lochhead and Rev. Father Leopold.

Delegates to the Canadian Branch of the American Phytopathological Society, Dr. B. T. Dickson, Rev. Father Leopold, Mr. O. Caron and Mr. J. J. Coulson.

Delegate to the Toronto meeting of the British Association.—Dr. E. Melville DuPorte.

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Maheux, G. . . . . Provincial Entomologist, Quebec.
Major, T. G. . . . . Tobacco Division, Dept.of Agriculture, Ottawa.
McLennan, A. H. . . . . Ontario Agriculture College, Guelph, Ont.
McMahon, E. A. . . . . John Coawan Chemical Co., Montreal.
McOuat, J. E. . . . . Kenogami, P. Q.
McRostie, Dr G. P. . . . . C. E. F. Ottawa.
Ménard, J. H. . . . . Forestry School, Berthierville.
Milne, A. R. . . . . D. S. C. R., Ste. Cathatines, Ont.
Moore, G. A. . . . . 159 Querbes Ave., Outremont.
Nagant, H. . . . . 64 Maple Ave., Quebec.
Newton, Miss Dorothy. . . . . Manitoba Univ. Winnipeg.
Nolet, Louis . . . . Collège de Lévis, Lévis, P.Q.
Pasquet, Jos. . . . . Ste. Anne de la Pocatière.
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Reid, Peter. . . . . Chateauguay Basin, Que.
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Richardson, J. K. . . . . Fredericton, N. B.
Roy, H. B. . . . . Sudbury, Ont.
Saunders, L. G. . . . . Cambridge University, Cambridge, Eng.
Savoie, F. N. . . . . Dept. of Agriculture, Quebec.
Simard, J. . . . . Dept. of Agriculture, Quebec.
Simmons, P. M. . . . . Lab. of Plant Path., Saskatoon, Sask.
Smith, R. H. . . . . Macdonald College.
Southee, G. A. . . . . 356 Durocher St., Outremont.
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Stohr, Rev. L. M. . . . . Ironside, Que.
Strickland, E. H. . . . . Edmonton, Alberta.
Summerby, Prof. R. . . . . Macdonald College.
Swaine, Dr. J. M. . . . . Entomological Branch, Dept. of Agric., Ottawa
Tawse, W. J. . . . . Macdonald College.
Tessier, G. . . . . Forest Service, Quebec.
Vanterpool, T. C. . . . . Macdonald College.
Victorin, Rev. Bro. . . . . University of Montreal, Montreal.
Willey, Dr. A. . . . . 58 Metcalfe St., Montreal.
Winn, A. F. . . . . 32 Springfield Ave., Westmount.

HONORARY MEMBERS

James W. Robertson, Esq., LL.D., C.M.G., Ottawa.
Hon. J. E. Caron, M.P.P., Minister of Agriculture, Quebec.
F. C. Harrison, D. Sc., Macdonald College.
Rev. Father Superior Dom Pacome Gaboury, La Trappe, Que.
Auguste Dupuis, Village des Aulnaies.
Canon, V. A. Huard, D.Sc., Quebec.
Rev. Father Superior, Ste. Anne de la Pocatière.
J. C. Chapais, D.Sc., St-Denis-en-bas, Que.
A. Gibson, Esq., Dominion Entomologist, Ottawa.
Hon. Minister of Crown Lands and Forests, Quebec.

FINANCIAL STATEMENT

QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS.

Sixteenth Annual Meeting.

RECEIPTS

Balance forward	$183.73	
Government Grant	250.00	
Interest	13.20	
		$446.93

EXPENDITURES

Printing, Postage	17.33	
Lecturers at Ann. Meeting	91.16	
General expenses of Meeting	15.00	
Secretary	50.00	
Delegate to Royal Society	12.00	
Delegates to Entomological Society	11.00	
Delegates to Phytopathological Society	37.25	
Grant for Experiments on Onion Maggot Control	38.70	
Balance in hand on May 10th, 1924	174.49	
		$446.93

E. M. DuPorte,
Auditor.

W. Lochhead,
President.

B. T. Dickson,
Sec. Treasurer.

Note.—Two small accounts outstanding at this date.

ANNUAL MEETING

The Sixtee th Annual Meeting of the Quebec Society for the Protectoni of Plants was held in the Biology Building on Wednesday, April 23rd, 1924. There was a very satisfactory attendance of members, some forty being present at the afternoon session and over fifty at the evening meeting. Special speakers included Prof. Dalbis of the University of Montreal, Prof. Howitt of the Ontario Agricultural College and Dr. Brittain of the Truro Agricultural College. Prof. Dalbis gave an extremely able and interesting illustrated lecture on "Fabre, his life and work" which unfortunately is not included among the printed papers in the report.

Principal F. C. Harrison, D. Sc., F.R.S.C. gave a very hearty welcome on behalf of himself and Macdonald College to the invited speakers and to the members. He pointed out the value of bringing experts in to the Society from other centres of scientific endeavor, both from the point of view of hearing them officially and of discussing with them informally the many difficult problems which present themselves in the study of plants in health and disease. He took the opportunity of reminding his hearers of the grave setback given to such work by non-continuance of the Federal Grant.

The business meeting opened at 11 a.m. with Rev. Father Leopold in the chair—the President, Prof. Wm. Lochhead being in England.

The minutes of the last meeting were approved.

The report of the Secretary-Treasurer was read and accepted.

The following officers were then elected for the year 1924-25:—

President:—Prof. W. Lochhead, Macdonald College.
Vice-President:—Rev. Father Leopold, La Trappe.
Secretary-treasurer:—Dr. E. Melville DuPorte, Macdonald College.
Directors:—C. E. Petch, Esq., Hemmingford, Que.
Prof. Father Louis Marie, La Trappe.
A. F. Winn, Esq., Montreal.
Prof. Bro. Victorin, Univ. of Montreal.
G. Maheux, Esq., Provincial Entomologist, Que.
Dr. B. T. Dickson, Macdonald College.
G. Bouchard, M.P., Ste-Anne de la Pocatière.
Dr. A. T. Charron, St-Hyacinthe, Que.
Auditor:—J. G. Coulson, Esq., Macdonald College.

Delegate to the Royal Society of Canada:—Dr. Dickson.

Delegates to the Ontario Entomological Society:—Prof. W. Lochhead. and Rev. Father Leopold.

Delegates to the Canadian Branch of the American Phytopathological Society:—Dr. B. T. Dickson, Rev. Father Leopold Mr. O. Caron and Mr. J. G. Coulson.

Delegate to the British Association Meeting in Toronto, August, 1924:— Dr. E. M. DuPorte.

It was resolved that the Society so far as funds are available, continue to help in aiding investigations concerning economic diseases caused by insects, fungi, or bacteria.

A REVIEW OF OUR KNOWLEDGE CONCERNING IMMUNITY AND RESISTANCE IN PLANTS

J. E. Howitt, Professor of Botany, Ontario Agricultural College, Guelph, Ont.

Immunity and resistance in plants is a subject of great possibilities to the Plant Pathologist. It appears to offer a solution for some of our most out-standing and important pathological problems, such as the prevention of loss from grain rusts; the control of citrus canker in the south; the re-establishment of the American chestnut in the United States; the production of beans free from anthracnose, mosaic and root rot; and the prevention of soil diseases, such as cabbage yellows, flax wilt, cotton wilt, tobacco root rot, and stem and root rot of canning peas. It offers to the man of scientific inclination a host of intricate and fascinating problems in the fields of bio-chemistry, plant physiology, genetics and ecology. It is by no means a new subject. We find it stated in "Diseases of Field and Garden Crops" by Worthington Smith, published in 1884, that "Experiments are now being carried out under the auspices of the Royal Agricultural Society to improve qualities of the potato, especially in its power of resisting attacks of the potato disease, by crossing S. tuberosum L. with its allies, and among them S. Maglia, Sch." (1).

Let us very briefly note some of the more important accomplishments in the production of disease resistant plants. W. A. Orton by selection, succeeded in producing a number of varieties of cotton resistant to wilt (Necomospora vasinfectum) and by crossing the citron with the water-melon he produced a commercial water-melon resistant to wilt caused by a soil Fusarium (2). It is interesting to know that this water-melon did not prove to be resistant when grown on the Pacific coast. Bolley by selection has produced strains of flax resistant to wilt (Fusarium lini). J. B. Norton by hybridization has furnished asparagus growers with varieties resistant to rust, such as Martha and Mary Washington (3). L. R. Jones has supplied Wisconsin cabbage growers with commercial varieties of cabbages resistant to yellows, caused by the fungus Fusarium conglutinans. Johnson has by hybridization and selection produced strains of White Burley tobacco showing marked resistance to root rot caused by Thielavia basicola. The immunity of many commercial varieties of potatoes to canker or wart disease has been demonstrated in Germany, Holland, England and America, and affords a striking instance of practical control by substitution of immune for susceptible varieties.

Time will not permit of any extended review of the progress that has been made with the wheat rust problem in the production of resistant varieties.

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1. Smith Worthington G. Diseases of field & Garden Crops.
2. Smith, Erwin F. Royal Hort. Soc. Rept. 1907.
3. Norton J. B. Washington Asparagus, U. S. Sept. of Agr. (Office Cotton Truck & Forage Crop Disease Cir. 7, 1919.

It may be noted however, that the chief advance so far has been in the solving of many of the fundamental problems in genetics, and in the isolating of the numerous biologic strains which constitute Puccinia graminis tritici. One cannot refer to this important work without mentioning the names of Eriksson Biffin, Stakman, Pole Evans and Melchers. One of the most promising reports, in that it offers scientific evidence as to the possibility of producing varieties of common wheat resistant to a large number of biologic forms of stem rust, is that of Aamodt (1), in the Journal of Agricultural Science on the "Inheritance of growth habit and resistance to stem rust in a cross between two varieties of common wheat. He reports "That the resistance and susceptibility of the host to several different forms of rust, are inherited as a single genetic factor."

The work that has been done in the breeding and selection of beans resistant to anthracnose illustrates the complications of such a problem due to the existence of different biologic strains of the fungus. In 1911 M. F. Barrus, of Cornell, proved that there were at least two distinct binologic strain of Colletotrichum lindemuthianum in New York State which he designated as alpha and beta. Nearly all the varieties of beans tested by Barrus were susceptible to one or the other of these strains. A few however, were resistant to both, among these were Wells Red Kidney and White Imperial (2). From these two varieties Burkeholder, McCrostie and Reddick developed several other commercial varieties of beans resistant to anthracnose in New York. Burkeholder later showed the existence in New York of a third biologic strain which he called the gamma strain, and demonstrated that neither Wells Red Kedney, nor White Imperial were resistant to it. In fact Wells Red Kidney, which hitherto had been considered the most resistant variety of all to the anthracnose fungus was especially susceptible to this third biologic strain (3). J. B. Leach (1923) reports that in Minnesota there are at least eight distinct biologic strains of Colletotrichum lindemuthianum (4). The presence of these distinct biologic strains in different localities complicates the problem of the breeding of anthracnose resistant varieties. It would appear that the biologic strains in any locality must first be isolated and varieties bred and selected in relation to them. Probably the most practical progress that has been made in the production of disease free beans is the work of Reddick and Stewart in proving that the robust bean is immune to the mosaic disease. Burkeholder states that the growing of pea beans in New York State had been practically discontinued due to the mosaic disease, but as a result of the intro-

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1. Aamodt, Olaf. S. Jour. Agr. Res. 24; 457-469, 1923.
2. Barns, M. F. Phytopathology 1: 190-195, 1911.
3. Burkcholder, W. H. Phytopathology 13 316-323, 1923.
4. Leach, J. G. Minnesota Agr. Expt. Sta. Tech. Bul. 14, Mch 1923.

duction of the robust, the acreage of the pea bean is now as large as formerly (1).

Other promising results with disease resistant plants are those of Coons of Michigan, from his work on seed production of Golden Self-blanching celery resistant to Yellows, (Fusarium sp.) (2) and those obtained by Jagger, who selected eight varieties of lettuce apparently immune to mildew (Bremia lactucae Reg.) in both California and Florida. These varieties were however, all of European origin and not suited to American conditions, so they were hybridized with the popular variety Los Angeles Market or New York, which is sold under the name of Iceberg lettuce. This variety is very susceptible to mildew. The results in the second generation indicate that immunity is inherited as a simple Mendelian dominant character, so that it is expected that hybridization and selection will give immune strains of New York and other popular varieties of lettuce.

Let us next consider the nature of immunity and resistance and review the scientific evidence available concerning the causal factors. In any discussion of this kind, one must keep in mind that there is immunity, resistance, apparent resistance or apparent immunity and tolerance, and there is a danger of confusion them.

True immunity or complete resistance to disease is rare among plants, but we have such examples of it in the varieties of potatoes immune to potato wart or canker; buri cotton in India immune to wilt, caused by Fusarium.

Resistance, as the term is used by plant pathologists, is in reality relative immunity or relative resistance to infection. Plants which are said to be resistant to a particular parasite are affected by it but the attack is slight as compared with that on the less resistant kinds. Resistance is much more common than immunity. It is recorded as occurring among the various varieties of nearly all our cultivated plants. True immunity and resistance being relative terms no attempt will be made to deal with them as separate phenomena in this paper.

Apparent immunity or resistance, which is in reality escape from disease is quite distinct from, and should not be confused with, true immunity or true resistance. Plants may escape disease for various reasons, such as climate and seasonal conditions unsuitable to the parasite; absence or scarcity of insect carriers of the inoculum; absence from the locality of the particular biologic strain of the pathogene capable of infecting the variety supposed to be resistant. In Ontario many of our early potatoes escape late blight and

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1. Burkeholder, W. H. Phytopothology 14, 1-8, ja. 1924.
2. Coons, G. H. Miltose, Ray. Phytopathology, 13, 24 Ja. 1923 (Abstract).
3. Jagger Ivan E. Phytopathology 14, 122, F. 1914 (]Abstract).

rot because they have completed their development before the season of the year that climatic conditions become such as to allow for the spread and development of the pathogene. Early varieties of oats frequently escape rust, apparently for the same reason. On the College Farm at Guelph, during the past two years, no bunt has developed in spring wheat, even when the seed was covered with smut sportes before seeding. This is an example of escape and not of resistance, as the variety of wheat sown was known to be subject to bunt in Western Canada. The escape was probably due to the high temperatures just after seeding, which were unfavorable to the germination of the spores of the bunt fungus. In Northern Ontario leaf roll of potatoes does not appear to spread. A variety grown on the same farm for years often remains apparently immune to leaf roll, whicle the same variety when grown in Southern Ontario for two or three years becomes badly affected with it. The apparent immunity to leaf roll of potatoes in Northern Ontario, is, in the opinion of the writer, probably an instance of escape due to the comparative scarcity of aphids and other insect carriers of the inoculum of leaf roll. Examples of escape due to the absence of certain biologic strains of the pathogene are seen in the cases of varieties of wheat, which, when grown in certain localities, appear to be highly resistant to stem rust, but which, when grown in other places, prove to be susceptible. Another illustration of escape of this nature is Wells Red Kidney bean, which appeared to be resistant to the bean anthracnose fungus in New York, until the discovery of the gamma strain of the fungus by Burkeholder.

Tolerance of disease is again distinct from immunity and resistance. It may be due to strong and vigorous growth. Tolerance is seen in the case of the round-leaved mallow (Malva rotundifolia) attacked by Puccinia malvacearum. Frequently mallow plants are seen with the lower surface of the leaves covered with telia, but the plants never appear to be seriously injured by the fungus. On the other hand, hollyhock leaves affected by the same fungus usually wither and die before the normal time. Too many of our weeds appear to be tolerant of parasitic fungi. Tolerance is sometimes due to the fact that the tissues of the host are able to react so as to lessen the injury. Butler cites as an example of the type of tolerance, tea affected by red rust (Cephaleuros mycoidea). The chief damage of the pea plant by this organism is to the young twigs not protected by bark. The parasite works from the surface towards the wood, it cannot penetrate cork. The tissues of the twigs respond to the attack of the parasite by laying down corky tissues under the point of infection, thus preventing further penetration and injury by the parasite! It is possible that we have another example of such tolerance among varieties of potatoes infected by Spongospora subterranea.

The causes for apparent resistance or immunity to disease and tolerance are comparatively easily explained. But when we consider the causes for

true immunity and resistance, we find ourselves involved in a maize of anatomical, physiological, bio-chemical and ecological evidence and theories which have been offered, some to explain specific cases of resistance and other to explain the problem in general. Before entering into a discussion of these it is well to have clearly in our minds the fact brought out by Butler in his paper on "Immunity and Disease in Plants" (1) that what we commonly think of as infection consists of two stages; the first being the entrance of the parasite into the tissues of the plant, and the second the establishment of parasitic relationship with the host. Some fungi, such as the rusts, enter many plants from which they cannot obtain nourishment, and consequently perish because they are not able to accomplish the second stage of infection.

After considering these two stages of infection one realizes that immunity and resistance may be due to morphological and anatomical characters of the plant which prevent the first stage of infection, or entrance of the parasite into the tissues; or to bio-chemical properties or anatomical characters of the tissues of the host which prevent the second stage of infection or the establishment of parasite relation ship with the tissues of the plant.

Some students of this subject consider that immunity due to morphological and anatomical characters preventing the first stage of infection is disease escape, and confine the term immunity to those cases, due to lack of comptability of the parasite with the tissues of the plant.

Cases of immunity or resistance due to the anatomical characters of the host preventing entrance to the parasite are comparatively numerous (3). Coffee leaf disease usaully starts on the undersurface of the leaf as there are few stomata on the upper surface. Young beat leaves are practically immune to attacks by Cercospora beticola because their stomata are so small as to be incapable of opening widely enough to allow for the entrance of the germ tube of the spores of the fungus, which can only enter the host through the mature stomata (4). Certain varieties of plums are resistant to brown rot caused by Scletrotinia cinerea, beacause the stomata soon become plugged with masses of small parenchymatous cells. The toughness of the skin, the firmness of the flesh, and high fibre contents are also important characteristics which make varieties of plums resistant to brown rot. It has been found that as ripening progresses the texture of the resitant varieties remains firm, while that of the susceptible becomes softer. The stomata of Kanred wheat, which is resitant to certain strains of Puccinia graminis tritici, are said to be of such a nature as to "shut out most of the fungi"(6). In a more recent paper by Allen it is

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1. et 2. Butler, Edwin John, Immunity and disease in Plants, Agr. Jour. India 1918, (Spec. Indian Sci. Congr. No. 1028, 1918.
3. Butler, Edwin John, l.c.
4. Pool Veniss Morrel & McKay, Marion B. Jour. Agr. Res. 5, No 2, No 22, 1011-1038, 1916.
5. Valleau, W. D. Jour. Agr. Res. 5, No. 9, 365-395. N. 29, 1915.
6. Allen R. F. Jour. Agr. Res. 23:2. 131-132, 1923.

pointed out that there is a tendency in wheat to keep many of its stomata closed and it is suggested that the secretion by the appressorium renders the mechanism of the stomata inoperative and they remain closed, thus excluding the fungus. It is also pointed out that in Kanred wheat with its smaller stomata, these peculiarities of stomatal behaviour might be more effective in excluding fungi than in varieites of wheat with larger stomata (1). It has been shown that the resistance of Citrus nobilus to citrus canker is due to a broad ridge overarching the outer chamber of the stomata, which practically excludes water from them, thus preventing the entrance of the canker bacteria (2). Appel states that the resistance of some Remontant carnations to rust is due to the formation of the stomata which makes it impossible for the hyphae to penetrate (3). Neger, studying the biology of the Erysiphaceae and making cross inoculations, found that in some cases in which host plants showed resistance, that many of the penetrating haustoria become eveloped in a gummy deposit secreted by the epidermal cells, which prevents them entering the plant (4). The resistance of certain varieties of barley to rust is due to the bloom (waxy coating) on the leaves which prevents drops of water adhering to them, consequently the rust spores are unable to germinate on them. It is also recorded by Appel that the more waxy varieties of raspberries and grapes are those less damaged by Coniothyrium (5). Lutman from his investigations regarding the resistance of potato tubers to scab (Actinomyces scabies) states "that at the head of the resistant class stand the potatoes of the russet type and that thickness of skin determines resistance of tubers to scab." He also records that close texture lenticels partly buried under the skin surface and filled with small cells are also associated with the russet type of potatoes.

It is thought that the hairs on the leaves may influence resistance. Appel states that varieties of potatoes with small hairy leaves and open habit of growth dry quickly after wetting and are less liable to infection by Phytophthora infestans than other kinds. It is probable that the open habit of growth and not the abundant hairs is the chief factor with such varities! It is also asserted that "hairs also seem to save the under surface of the apple leaves from infection with the apple sacb fungus (Venturia inecqualis), while Venturia Pyrina readily attacks the smooth under-surface of the pear leaves" 7. This statement does not agree entirely with my own observations in regard to the scab on apple. I have frequently observed that most, if not all primary infection by apple scab is on the lower surface of the leaves. It is also a matter of common observation that the young fruits, while still covered with down are very susceptible to scab. It is interesting to note in this connection that

1. Allen R. F. Jour. Agri. Res. 24: 12, D. 1923.
2. McLean Forman L. & Lee. H. Atherton. Phytopath, 11: 109-114. Mar. 1921.
3. Appel, D. Science, N. S. 41, No 1065: 773-782, May 28, 1915.
4. Niger, F. W. Flora CXVI. 3, 331-335, 1923.
5. Lutman, B. F. Vir. Agr. Expt. Sta. Bul. 215, Je. 1919.
6. Appel. O. l.c.
7. Butler Edwin John, l.c.

the very hairy Common Mullein (Verbascum thapsus) is attacked by six leaf inhabiting parasitic fungi, while but three are reported as occuring on the labrous Moth Mullein (Verbascum blattaria.)

Morphological structures peculiar to varieties influence susceptibility. Varieties of pears with an open channel from calyx to core are those most susceptible to Fusarium putrefaciens, a fruit-rotting organism. Appel attributes the immunity to loose smut in wheat and barley to the closed flowers found in the resistant varieties. Fromme, calls attention to the fact that this cannot be the explanation for resistance in the case of wheat, no varieties of which have closed flowers, according to the information avaliable to him (1). It does however, explain the immunity found among varieties of barley to loose smut, as some varieties of barley undoubtedly have flowers which do not open and expose the stigmas to infection. The rare occurrence of Claviceps purpurea on what is said to be due to the brief and irregular openings of the glumes as maturity (2). It may be of interest to note that the writer's attention was this spring called to a lot of seed wheat (wild goose variety) that contained considerable ergot.

Let us next consider cases of immunity due to incompatability of the invading organism with the tissued of the plant, or in other words the failure of the organism to accomplish the second stage of infection, the establishment of parasitic relationship with the host. The prevention of this second stage of infection is, in some instances due to the anatomical characters of the host tissue, but more often to bio-chemical properties of the cells. Examples of structural characters influencing resistance have been observed in plums attacked by Sclerotinia cinerea, and potato tubers infected by Pythium debaryanum. Some varieties of plums become more liable to rot when they begin to ripen. This is due to a softening of the middle lamellae between the cells which allows the fungus to force its way through the tissues more rapidly (3). In making a physiological study of the parasitism of Pythium debaryanum on the potato tuber, Hawkins and Harvey found that the fungus secretes a toxin which kills the cells, and an enzme which breaks down the middle lamellae but does not affect to any extent the secondary thickenings. They observed that White McCorminck, a potatoe very resistant to Pythium debaryanum has a higher crude fibre contents than that of suceptible varieties. This higher fibre content they attribute to more secondary thickenings in the cell walls. Resistance to infection, they found, is apparently due to the resistance of the cell walls to mechanical puncture by the invading hyphae (4).

When we come to consider cases of immunity due to bio-chemical properties of the cells we find ourselves confronted with many complicated theories, some

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2. Stager, R. Mitt. naturforach, Gesellch, Bern. 1922, pp. 11-20, 1923.
3. Valleau, l.c.
4. Hawkins, Lona and Harvey, Rodney B. Jor. Agr. Res. 18, No 5, Dec. 1, 1919.

of them more speculations. All however, support the general fundamental theory that such immunity is owing "to a definite antagonistic chemical inter-action between host and parasite."

Maryatt, and later Stakman, showed that resistance of some plants to rust is due to the dying of the cells surrounding the point of infection, and thus starving the obligate parasite. This is termed super-sensitivity (1). The cause for the dying of the cells surrounding the point of infection in advance of the invasion of the parasite has not been determined, bub it would seem from the recentwork of Allen that it is bio-chemical. J. G. Leach states that in a variety of bean highly resistant to Colletotrichum lindemuthianum seldom more than one or two cells are attacked, and that all evidence seems to indicate that resistance is due to the inability of the fungus to obtain nourishment from the living protoplasm. What is the bio-chemical property of the host cells of resistant varieties of beans that makes it impossible for the invading hyphae to obtain nourishment form them? This question has not been answered

Tannin is very frequently found in vegetable cells and is, as a rule, toxic to fungi. Cook and Taubenhaus point out the fact that the beans are more susceptible to Colletotrichum lindemuthaianum during those stages of their growth when the enzyme which acts on gallic acid in the cells to form tannin is least abundant. In apples pears and persimmons, and other fruits, this enzyme is less abundant when the fruits are ripe than when they are green (3). This may explain the decreased resistance to rots observed in ripe fruits. Cook found that tannin effects the various species of Endothia very differently. E. radicalis and E. Gyrose are inhibited by it, while E. parasitica is at first retarded and later is able to feed on the tannin (4).

Acidity of the cell sap evidently plays some part in resistance to Guignardia bidwellii, and varieties of grapes containing less tartaric acid in thier celle sap have been found to show to show greater resistance to Guidnardia bidwellii than those containing higher quantities. Botrytis has been shown to be repelled by certain acids found in plant cells. The resistance of grapes to powdery mildew (Uncinula necator) has also been correlated with the acidity of the cell sap, the resistant varieties containing more tartaric acid than the less resistant kinds. Comes, an Italian investigator has drawn attention to the fact that Rieti, a variety of wheat strongly resistant to rust in Italy, has a more acid sap than that of any of the other less resistant kinds tested, and that loss of resistance in this wheat when grown in warmer localities than its native area is correlated with reduced acidity of the sap (5). Popp, in his investiga-

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1. Stakman, E. C. Phytopath, 4:400. D. 1914 (Abstract).
2. Leach, l.c.
3. Cook, M. F. & Fautenhans, J.J. Deleware Agr. Erp. Sta. Bul. 98, Jy. 1912.
4. Cook, M. F. & Wilson, G. W. New Jersey, Agr. Exp. Sta. Bul. 291, 1916.
5. Butler, l.c.

tions concerning the hydrogen-ion concentration and natural immunity of plants found that injections of pathogenic bacteria cause the plants to respond with variations in the hydrogen-ion concentration. Immediately after infection the acidity decreases. At the end of the incubation period the acidity rises. If the plant is able to withstand the infection the acidity then falls back to normal. If the plant is unable to withstand the infection, hydrogen-ion concentration rises to a very high level, and then falls, usually below normal!

Other cell contents besides those already discussed appear to account for some cases of resistance. Biologic species of parasitic fungi are known to be very sensitive to the minutes differences in the albumen contents of the host plants. This may explain with some varities of plants are resistant to certain biologic strains and not to others. Walker in his researches on disease resistance to onion smudge, found that some substance (or substances) closely associated, or identical with, the yellow and red pigments found in the cells of the other scales of the resistant bulbs, was evidently the chief cause of resistance to onion smudge (2) (Colletotrichum circinans). It has been found that the leaves of certain species of oak immune to powdery mildew have a smaller soluble nitrogen content than the leaves of susceptible species (3). The paper by Lepschkin on the "Influence of Vitamines upon the development of yeasts and moulds" (4) makes one speculate as to the part that these vital substances may play in resistance in plants. This is a field of future reasearch for the bio-chemist.

Our present knowledge of immunity and resistance in plants would seem to warrant the following statements.

First.—That substantial and permanent progress has been made in the production and selection of resistant varieties of plants.

Second.—That further and more extensive studies concerning the existence of biologic straims of different parastitic fungi are required.

Third.—That our knowledge concerning the bio-chemical causes of resistance is fragmentary and disconnected.

Fourth.—That future reaserch work on this subject lies largely in the filed of bio-chemistry.

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THE DEVELOPMENT OF APPLIED ENTOMOLOGY IN CANADA

1914-1923

By Arthur Gibson, Dominion Entomologist, Ottawa.

In the period covered by this review much progress has been made in applied entomology in Canada, both in the federal and provincial services (1). In discussing the development of this branch of science, I shall first of all refer to the federal organization at Ottawa and then discuss important progress

(1) In the 45th Annual Report of the Entomological Society of Ontario, for 1914, the late Dr. Hewitt contributed an article entitled "Applied Entomology in Canada; Its Rise and Progress". This paper discussed the subject up to about the year 1914.

which has taken place in the various provinces, as a result of federal, provincial, or other activities.

Federal Organization

Since 1914, the federal entomological service has developed to a marked degree (1). At that time the permanent staff including entomologists and clerical workers, numbered 20, in addition to which a few students were employed at Ottawa, during the summer months. To-day the permanent staff numbers 58 and in addition, in 1923, 61 temporary assistants were employed; of this total, 15 comprised the clerical staff. In 1914, there was no divisional organization at Ottawa; now there are, in addition to my own administrative division, four definite divisions, namely: Division of Field Crop and Garden Insects, (R. C. Treherne, Chief in charge) (2); Division of Forest Insects, (J. M. Swaine, Associate Dominion Entomologist in charge); Division of Foreign Pests Suppression, (L. S. McLaine, Chief in charge); and Division of Systematic Entomology, (J. H. McDunnough, Chief in charge). Investigations relating to fruit insects, live stock insects, greenhouse insects and other pests, not conducted by the above divisions are under the immediate direction of the Dominion Entomologist.

Division of Field Crop and Garden Insects.

The work of the officers of this Division has had to do with the bionomics and control of such important pests as the various species of cutworms; the destructive species of grasshoppers which of late years have been particularly injurious in the Prairie Provinces; the European Corn Borer, of which the investigations relating thereto are showing much promise; the Western Wheat Stem Sawfly, which has developed to an alarming extent, particularly in Manitoba and Saskatchewan, and concerning the control of which important data have been secured; the Hessian Fly in Ontario, Manitoba and Saskatchewan, the so-called fly-free seeding dates for fall wheat being especially investigated in the former province; white grubs, from the study of which a short regular crop rotation will to a large extent prevent serious injury; alfalfa insects, including special investigations relating to the Alfalfa Thrips in southern Alberta; root maggots, studies of the control of which have demonstrated throughout Canada the value of the corrosive sublimate remedy for the Cabbage Root Maggot, and the sodium-arsenite bait combined with the sowing of culled onion sets as a trap for the Onion Maggot, etc. This Division has permanent field laboratories at Strathroy, Ont.; Treesbank, Man.; Saskatoon, Sask.; and Lethbridge, Alta., and temporary laboratories at other points.

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(1) During the eleven years of service of the late Dominion Entomologist Dr. C. Gordon Hewitt, the Dominion Entomological Service was developed from a very small division attached to the Experimental Farms Branch, to an important separate Branch of the Department of Agriculture.
(2) Obit., June 7, 1924.

Division of Forest Insects.

Officers of this Division have been engaged in investigating such important pests as the Spruce Budworm which during the last decade has ravaged spruce and balsam forests in Ontario, Quebec and New Brunswick; species of bark-beetles including the Destructive Spruce Bark beetle affecting all our species of spruce; the destructive pine bark beetles; the Douglass Fir Bark-beetle in British Columbia, and others which attack various coniferous trees; the Satin Moth, a European pest recently introduced into British Columbia, which attacks willows and poplars; the Larch Sawfly, which is increasing in eastern Canada and concerning which special life-history and parasite studies have been in progress in New Brunswick; the Fall Webworm, the Forest Tent Caterpillar, the White-marked Tussock moth, and other forest and shade tree pests which have received special study in New Brunswick, particularly with regard to their natural control by parasitic and other agencies. This Division, in addition, has established numbers of forest sample plots in Quebec, Ontario and New Brunswick, the trees in which are studied each year much valuable information being secured regarding the insects and other agencies which affect the health of the timber, and the extent to which each is injurious. The Division has permanent field laboratories at Fredericton, N. B; Aylmer, Que; Indian Head, Sask; and Vernon, B. C., and temporary laboratories in other districts.

Division of Foreign Pests Suppression.

The officers of this Division are specially charged with the administration of the Regulations of the Destructive Insect and Pest Act, in so far as insects are concerned. Previous to Sept. 1st, 1923, nursery stock entering Canada from countries other than Europe (including Great Britain) was subject to fumigation with hydrocyanic acid gas for a period of 45 minutes. Fumigation stations for this purpose were erected at St. John, N. B; St. Johns, Que; Niagara Falls and Windsor, Ont; Winnipeg, Man; North Portal, Sask; and Vancouver, B. C. In addition to fumigation, nursery stock from the States of Vermont, New Hampshire, Maine, Massachusetts, Connecticut and Rhode Island, and also from Europe and Asia, was inspected. During the ten years ending March, 1923, approximately, 20,000,000 plants were examined by federal inspectors, as a result of which such foreign pests as Gipsy Moth, Brown-tail Moth, Apple and Cherry Ermine Moths, European Corn Borer, San José and other scale insects, etc., were intercepted. Field scouting to reduce the infestation of the Brown-tail Moth in New Brunswick and Nova Scotia has been very successful. In addition, other scouting work has been conducted for such introduced pests as the European Corn Borer and the European has been conducted Apple Sucker as a result of which areas have been quarantined in Ontario, for the former insect and in Nova

Scotia for the latter. On April 21st, 1922, the Destructive Insect and Pest Act Advisory Board was created. The Dominion Entomologist was appointed Chairman of the Board and the Chief of the Division of Foreign Pests Suppression, Secretary. The revised regulations under the Destructive Insect and Pest Act went into effect on Sept. 1st, 1923, and were published as "Acts, Orders and Regulations No. 8, Dept. of Agriculture". This Division now maintains an inspection service at Halifax, N. S; St. John, N. B; Quebec, Que; Montreal, Que; Niagara Falls, Ont; Toronto, Ont; Windsor, Ont; Ottawa, Ont; Winnipeg, Man; and Vancouver, B. C.

Division of Systematic Entomology

The care and development of the National Collection of Insects is the chief concern of the officers of this division; taxonomic research, therefore, occupies much of their time. During the last ten years this collection has been enlarged very materially and excellent progress has been made in classifying the various orders of insects and describing numbers of species new to science, the types of which are deposited in the Entomological Branch. Such well known collections as the Harrington collection of Hymenoptera, the Woolly-Dod collection of Noctuidae, and the Sladen collection of wild bees, have been incorporated into the National Collection. This latter is undoubtedly becoming one of the most important collections of insects in North America, and as a consequence is of increasing value to economic workers, both federal and provincial. The following well known foreign specialists have visited Ottawa, during the period covered by this paper, for the purpose of examing material in the National Collection: J. M. Aldrich, H. G. Dyar, A. Busck, S. A. Rohwer, A. B. Gahan, W. Barnes, T. L. Casey, J. H. Emerton, W. T. M. Forbes, E. C. Van Dyke and H. J. Elwes.

Dr. McDunnough during recent years has made a special taxonomic study of the Ephemerida an insect order which has been much neglected by systematists. These insects, as is well known, are of considerable economic importance as food for fish. Other important studies have related to the Tabanidae by Dr. McDunnough, the Syrphidae and other dipterous groups by Mr. C. H. Curran, and parasitic and other hymenoptera by Mr. H. L. Vierick.

Introduction of Parasites of the Gipsy and Browntail Moths.

The introduction into eastern Canada, of parasites of the Gipsy and Browntail moths which was begun in 1912, was developed to a considerable extent in later years, such work being largely under the immediate direction of Messrs. J. D. Tothill and L. S. McLaine, assisted by Messrs. A. B. Baird, A. G. Dustan and R. P. Gorham. Up to 1917, the total number of parasites of the above

two moths imported from Massachussetts through the co-operation of the United States Bureau of Entomology, and liberated at strategic points in the provinces of Nova Scotia, New Brunswick and Quebec, were: *Apanteles lactiecolor* 67,500; *Compsilura concinnata* 30,725, and *Calosoma sycophanta*, 4,200. The importation of these enemies of the Gipsy and Browntail moths was discontinued in 1917, in order that more recovery work of the enemies introduced might be undertaken. The parasites mentioned have undoubtedly become established in eastern Canada, as they have been recovered on several occasions; the *Calosoma* has also been recovered.

Aid to Greater Production Campaign

The greater production campaign inaugurated by the Government during the Great War was aided considerably by entomologists throughout Canada, through lectures, correspondence and publications. A special series of articles of value to citizens engaged in war-garden work was prepared at Ottawa and given to the press at timely intervals. The late Dominion Entomologist, Dr. G. Gordon Hewitt, personally took a keen interest in the protection of stored grain from rats, mice and insects, and also prepared, for the Food Controller, a statement, issued in leaflet form, instructing householders as to methods of keeping breakfast foods and other products kept in store free from insect enemies. The federal Entomological Branch issued a series of circulars on important pests which were called "Crop Protection Leaflets." During this time too, the Branch adopted the slogan, "Crop Protection means Crop Production". The late Dr. Hewitt also prepared a leaflet entitled, "The Suppression of Two Insects affecting Troops", which was issued by the Department in 1916 for special distribution among the Canadian Expeditionary Forces.

Greenhouse Insect Investigations

At Ottawa and Vineland, studies have been undertaken of a number of the more important greenhouse insects, and a special bulletin on the subject was published in 1923.

Other Investigations.

Studies of insects affecting stored products, live stock, man and his personal belonging, etc., have also been investigated at Ottawa as opportunity offered. Fruit insect investigations, insecticide investigations and natural control investigations, have been specially conducted at certain field laboratories during the past decade and reference to such investigations will be made under the provinces in which they were undertaken.

Field Laboratories

In 1914, the Dominion Entomological Branch had nine field laboratories, each in charge of a trained entomologist. These laboratories were located at Bridgetown, N. S.; Fredericton, N. B.; Covey Hill, Que.; Jordon Harbour, Ont.; Strathroy, Ont.; Treesbank, Man.; Lethbridge, Alta.; Agassiz, B. C.; and Vancouver, B. C. In 1924, the Branch maintained 20 laboratories, namely, at Annappolis Royal, N. S.; Kentville, N. S.; Wolfville, N. S.; Fredericton, N. B.; Hemmingford, Que.; Aylmer, Que.; Ottawa, Ont.; Vineland, Ont.; St. Thomas, Ont.; Port Stanley, Ont.; Strathroy, Ont.; Treesbank, Man.· Indian Head, Sask.; Saskatoon, Sask.; Lethbridge, Alta.; Banff, Alta.; Vernon, B. C.; Nicola, B. C.; Agassiz, B. C.; and Victoria, B. C. All of these with the exception of Kentville, Wolfville, St. Thomas, Port Stanley, Banff and Nicola, may be regarded as permanent in nature.

Library.

During the last ten years the library of the Entomological Branch, established at Ottawa, has assumed important proportions, and it is now undoubtedly one of the best libraries of its kind in Canada. Sets of most of the entomological journals of the world have been completed and many rare and valuable works of reference for the systematist added. The series of economic bulletins, reports, etc., published by various states and governments have also been largely added to, and an endeavor is being made to receive all current literature as issued.

Publications.

Up to 1914, the federal Department had published 6 Entomological Bulletins and 2 Circulars. From 1914 to 1923 inclusive, 18 Entomological Branch Bulletins, 13 Entomological Branch Circulars, 16 Crop Protection Leaflets, 4 Entomological Circulars (Department of Agriculture, New Series), and 7 Entomological Pamphlets (Department of Agriculture, New Series) were published. These are as follows:

Bulletins :

No. 7.—Forest Insect Conditions in British Columbia.—By J. M. Swaine, 1914.
8.—The Strawberry Root Weevil in British Columbia.—By R. C. Treherne, 1914
9.—The Army-worm.—By Arthur Gibson. 1915.
10.—Cutworms and their control.—By Arthur Gibson. 1915.
11.—The Hessian Fly and the Western wheat stem Sawfly.—By Norman Criddle. 1915.
12.—The Cabbage Root Maggot and its Control in Canada.—By Arthur Gibson and R. C. Treherne. 1916.
13.—The Army Cutworm.—By E. H. Strickland. 1916.
14.—Canadian Bark Beetles.—By J. M. Swaine, 1917.
15.—The Pear Thrips and its control in British Columbia.—By A. E. Cameron and R. C. Treherne. 1918.

16.—The Apple Bud-moths and their Control in Nova-Scotia.—By G. E. Sanders and A. G. Dustan. 1919.
17.—The Fruit worms of the apple in Nova Scotia.—By G. E. Sanders and A. G. Dustan. 1919.
18.—Studies in North America Cleorini (Geometridae).—By J. H. McDunnough, 1920.
19.—The Natural Control of the Fall Webworm in Canada.—By J. D. Tothill. 1922.
20.—The Morphology and Biology of a Canadian Cattle-infesting Black Fly.—By A. E. Cameron. 1922.
21.—Insects affecting Greenhouse Plants.—By Arthur Gibson and W. A. Ross. 1922.
22.—Biological Notes on Parasites of Prairie Cutworms.—By E. H. Strickland. 1923.
23.—North American Cerambycid Larvae.—By F. C. Craighead. 1923.
24.—Insects affecting Live Stock.—By S. Hadwen. 1923.

Circulars:

No. 3.—The Chinch Bug in Ontario.—By H. F. Hudson. 1914.
4.—Instructions to Importers of Trees, Plants and other Nursery Stock into Canada.—By C. G. Hewitt. 1914.
5.—The Control of Locusts in Eastern Canada.—By Arthur Gibson. 1915.
6.—The Control of Cutworms in the Prairie Provinces.—By. E. H. Strickland. 1916.
7.—Results from Spraying in Nova Soctia.—By G. E. Sanders and W. H. Brittain. 1916.
8.—Spraying for Insects affecting apple orchards in Nova Scotia. By G. E. Sanders and W. H. Brittain. 1916.
9.—Common Garden Insects and their control.—By Arthur Gibson. 1917. Reprinted in 1921.
10.—Regulations under the Destructive Insect and Pest Act. By C. G. Hewitt. 1917.
11.—The White-marked Tussock Moth and Its Control.—By J. M. Swaine and G. E. Sanders. 1918.
12.—Directions for Collecting and Preserving Insects.—By J. H. McDunnough. 1919. Reprinted as Pamphlet No. 14, N. S., Dept. of Agric., 1922; Revised Edition, 1923.
13.—Locust Control in the Prairie Provinces.—By Norman Criddle. 1920.
14.—Boring Caterpillars Affecting corn and other crops and which are liable to be mistaken for the European Corn Borer.—By Arthur Gibson. 1920.
15.—The Control of Bark-beetle outbreaks in British Columbia.—By Ralph Hopping. 1921.

Crop Protection Leaflets :

No. 1.—Protection of Crops.—By C. G. Hewitt. 1917.
2.—Prepare to Protect your crops next Season.—By C. G. Hewitt. 1917.
3.—Cutworms and Their Control.—By Arthur Gibson. 1918. Reprinted 1919.
4.—Root Maggots and Their Control.—By Arthur Gibson. 1918.
5.—Prevent White Grub Injury.—By Arthur Gibson. 1918.
6.—How to Control Locusts or Grasshoppers.—By Arthur Gibson and Norman Criddle, 1918. Reprinted, 1919.
7.—Rats and Mice.—By C. G. Hewitt. 1918.
8.—Aphids or Plant Lice.—By W. A. Ross. 1918. Enlarged and reprinted 1923, as Pamphlet No. 31, N.S., Department of Agriculture.
9.—The Pea Weevil.—By Arthur Gibson. 1918.
10.—Arsenate of Lime.—By G. E. Sanders. 1918.
11.—The date on which it is Safe to reseed fields in the Prairie Provinces after they have been devastated by Cutworms.—By E. H. Strickland. 1921.
12.—The Beet Webworm.—By E. H. Strickland, and N. Criddle 1919. Reprinted as Circular No. 14, Department of Agriculture, 1923.
13.—The European Corn Borer.—By Arthur Gibson and L. S. McLaine. 1920.
14.—The Control of Grasshoppers.—By Norman Criddle and A. V. Mitchener. 1921.
15.—The Pale Western Cutworm.—By H. L. Seamans and E. H. Strickland. 1921.
16.—The Control of the European Corn Borer.—By H. G. Crawford and J. G. Spencer. 1921.

Department of Agriculture Circulars:

No. 2.—Field Crop Insects.—By H. F. Hudson. 1922.
4.—The date on which it is safe to reseed fields in the Prairie Provinces after they have been devastated by the Pale Western Cutworn.—By H. L. Seamans and E. H. Strickland. 1922.
12.—How to Foretell Outbreaks of the Pale Western Cutworm in the Prairies Provinces.—By H. L. Seamans, 1923.
14.—The Beet Webworm.—By E. H. Strickland and N. Criddle. 1923.

Department of Agriculture Pamphlets:

No. 5.—The Strawberry Root Weevil.—By W. Downes. 1922.
6.—The Western Wheat-Stem Sawfly and its Control.—By Norman Criddle. 1922.
30.—The Hessian Fly in the Prairie Provinces.—By Norman Criddle. 1923.
32.—Root Maggots and their Control.—By R. C. Treherne. 1923.
33.—Wireworm Control.—By R. C. Treherne. 1923.

Reports of the Canadian Arctic Expedition

The insect reports published by the Dominion Government were completed in 1921. The various parts are as follows:

INTRODUCTION.—By C. Gcrdon Hewitt.
Part A: Collembola.—By Justus W. Folsom.
Part B: Neuropteroid Insects.—By Nathan Banks.
Part C: Diptera
Crane-flies.—By Charles P. Alexander.
Mosquitoes.—By Harrison G. Dyar.
Diptera (Excluding Tipulidae and Culicidae).—By J. R. Malloch.
Part D: Mallophaga and Anoplura.
Mallophaga.—By A. W. Baker.
Anoplura.—By G. F. Ferris and G. H. F. Nuttall
Part E: Coleoptera.
Forest Insects, including Ipidae, Cerambycidae, and Buprestidae.—By J. M. Swaine.
Carabidae and Silphidae.—By H. C. Fall.
Coccinellidae, Elateridae, Chrysomelidae and Rhynchophora (excluding Ipidae). By C. W. Leng.
Dytiscidae.—By J. D. Sherman, Jr.
Part F: Hemiptera.—By Edward B. Van Duzee.
Part G: Hymenoptera and Plant Galls.
Sawflies. (Tenthredinoidea).—By Alex. D. MacGillivray.
Parasitic Hymenoptera.—By Charles T. Brues.
Wasps and Bees.—By F. W. L. Sladen.
Plant Galls.—By E. Porter Felt.
Part H: Spiders, Mites, and Myriapods.
Spiders.—By J. H. Emerton.
Mites.—By Nathan Banks.
Myriapods.—By Ralph V. Chamberlain.
Part I: Lepidoptera.—By Arthur Gibson.
Part J: Orthoptera.—By E. M. Walker.
Part K: General Observations on Insect Life in the Arctic.—By Frits Johansen.

Health of Animals Br anch, Department of Agriculture.

In 1916 this Branch published two bulletins as follows:

No. 21.—A Further Contribution on the Biology of *Hypoderma lineatum*.—By S. Hadwen.
22.—Observations on the Migration of Warble larvae through the Tissues.—By S. Hadwen and E. A. Bruce.

Imperial Bureau of Entomology.

The federal Entomological Branch assists, by contribution, in the upkeep of the Imperial Bureau of Entomology, and the Dominion Entomologist is a member ex-officio of the Management Committee. This Bureau established in 1913, is directed by Dr. Guy A. K. Marshall, assisted by Dr. S. A. Neave. It is maintained by contributions from the Imperial Government and the various Governments of the Empire. It is splendidly organized, is in touch with the chief entomologists throughout the Empire, assists in identification of doubtful material, and above all publishes *The Review of Applied Entomology* and *The Bulletin of Entomological Research*, of which the former especially, is of undoubted value to entomologists the world over.

The Imperial Bureau of Entomology has also been of assistance to Canadian entomologists in the granting of studentships for post graduate work. Messrs. J. D. Tothill and A. B. Baird of the federal service were assisted in this way. Dr. W. H. Brittain, Provincial Entomologist for Nova Scotia, was also granted a studentship.

The Honorary Advisory Council for Scientific and Industrial Research.

This Council has rendered immediate assistance in furthering entomological research; in 1919, it granted a studentship to Mr. Eric Hearle to permit him to undertake mosquito investigations in the Lower Fraser Valley, B. C., under the direction of the Dominion Entomologist. In 1921, Mr. Alan G. Dustan, of the Entomological Branch, was awarded a studentship to enable him to take up post graduate work on insect diseases, but owing to ill health he could not take advantage of this.

Progress in the Provinces.

NOVA SCOTIA

Federal:

The officers at the Annapolis Royal laboratory have been, during recent years, specially engaged in the development of improved and cheaper insecticides. Mr. Geo. E. Sanders had charge of this work until March, 1922, when he resignde to enter commercial work, since which date Mr. Arthur Kelsall has been in immediate charge. The success which has attended the work of these insecticide entomologists has indeed been remarkable. As stated in my report as Dominion Entomologist for the two years ending March, 1921, these researches have been of a comprehensive nature involving chemical studies of the insecticides under consideration, insectary studies on the effect of insect poisons, etc. As a result spray and dust calendars have been devised.

One of the important results of this work was the development and advancement of the dust method of pest control. The dust invented by Mr.

Sanders composed of dehydrated copper sulphate, calcium arsenate and hydrated lime, came rapidly into general, use not only in Canada but also throughout the United States and in other countries. Coincidentally better types of power dusters were manufactured, and each year brought a reduction in the price of the materials used due to more up-to-date methods of making and distribuing and to the larger scale on which such materials were being handled. Methods were developed for the utilization of white arsenic as an insecticide in Bordeaux mixture.

Other lines of investigation have received attention; the compatibility of various insecticides with various fungicides, foliage injuries resulting from sprays and dusts, their cause and prevention, insect repellents and attractants, new uses for insecticides, relative tests and efficiency of new insecticides, and so on.

More recently other new lines of work have been commenced. Among the more prominent of these may be mentioned the utilization of nicotine fumes and other gases as insecticides in connection with power-dusting machines, a study of various spray and dust "spreaders" and "stickers" and a study of the absorption of water-soluble arsenic by various materials.

Investigations of important fruit insects have also been conducted by officers attached to the Annapolis laboratory, such as life-history studies and control of the bud moths affecting apple, the fruit worms attacking orchard trees, the White-marked Tussock moth, the Green Apple Bug, the European Apple Sucker, etc., as well as certain insects affecting field and vegetable crops such as the Army Worm, the Colorado Potato Beetle, etc. For field crop work, a temporary laboratory was established at Kentville, in 1923. In insecticide and other investigations, our officers have had close co-operation with Prof. S. Blair, Superintendent of the Experimental Farm at Kentville.

The European Apple Sucker, *Psyllia mali* Schmidb., was first found in Nova Scotia in 1919 in the vicinity Wolfville, and has since spread through Kings county and into the counties of Annapolis, Hants, Colchester, Cumberland, Halifax and Lunenberg. In order to assist in the prevention of the spread of this insect from the Province of Nova Scotia, the federal Department of Agriculture placed the above areas under quarantine and no nursery stock liable to introduce the pest into new sections is allowed to be moved. In 1920, it was noted that a fungous disease, *Entomophthora sphærosperma* Fres., was attacking the Apple Sucker, and Mr. Allan G. Dustan was detailed to make an intensive study of the parasite with the end in view of assisting in its natural spread. This work has been remarkably successful, and in areas where the fungus was introduced artificially in 1922 and 1923, the Apple Sucker was practically exterminated. The provincial entomological laboratory at Wolfville was placed at our disposal. In 1920, Mr. Dustan also undertook a study of a fungous disease parasitic on the Green Apple Bug, *Lygus communis novascotiensis* Knight.

The winter scouting work for the nests of the Brown-tail Moth, conducted by the Division of Foreign Pests Suppression, in co-operation with the provincial Department of Agriculture, has assisted very materially in controlling this pest. During the winter of 1913-1914, 24,156 nests, containing living caterpillars were gathered. This number has been noticeably reduced during succeeding winters; in 1922-1923, only 492 winter nests were found. Altogether during the ten years under review 73,756 nests were collected in this province. Mr. F. C. Gilliatt has been locally responsible for the carrying on of this work during the past five years.

Mr. Joseph Perrin, of McNabs Island, has assisted the Division of Foreign Pests Suppression in the inspection of imported nursery stock at the port of Halifax since October 1913. Mr. Perrin has continued to take a keen interest in entomology, particularly in lepidoptera, and has brought together a collection of the local species which is undoubtedly of considerable importance.

Provincial

The staff of the Provincial Entomologist, Dr. W. H. Brittain, has been added to during recent years and an entomological laboratory established at Wolfville. This laboratory has been mainly concerned in problems relating to fruit growing. In all of this work a close co-operation with the federal service has been maintained. At Truro, studies of insects attacking vegetables were undertaken, the Cabbage Root maggot, *Hylemya brassicæ* Bouché, being especially investigated. For a period of nine years the latter insect was under close observation and the details of its control under Nova Scotia conditions thoroughly worked out.

The Department has published valuable bulletins, particularly on the Apple Maggot, the Green Apple Bug, the Apple Sucker, and the Potato Stem Borer. Recently ,material has been collected for a handbook of Nova Scotia insects and it is expected that this publication will contain an illustration of every insect included.

In connection with the Brown-tail Moth winter work directed by the federal Entomological Branch, the Department of Agriculture for Nova Scotia has contributed officers to assist in this work.

Agricultural College, Truro.

Several changes have been made in the legislation relating to insect pests during the past ten years. The Provincial Entomologist is the executive officer appointed for the purpose of carrying out the regulations under the act. The "Foul Brood Act" 1915, dealing with the prevention and treatment of diseases among bees is also administered by the Provincial Entomologist.

Soon after the discovery of the San José Scale in Nova Scotia in 1912, the Department established fumigation stations at Dibgy and Truro, for the purpose of treating all nursery stock entering the province. In 1920, these stations were closed and all shipments subject to fumigation were, thereafter, treated at a federal station. The province then required all shipments for Nova Scotia from provinces known to be infested by the San José Scale, to be fumigated before shipment under the direction of a provincial officer. In 1923, an order-in council was passed amending the regulations to conform with the federal regulations under the Destructive Insect and Pest Act dealing with the importation of plants and plant products.

In addition to the regular course in entomology given at the college, by the Provincial Entomologist and Professor of Entomology, short courses have been held in various parts of the province and at these the control of farm pests has been explained directly to the farmers. These short courses have done much to educate those in attendance in matters relating to insect control and many are putting the knowledge thus gained into practice.

The Acadian Entomological Society

This society which until 1921 was known as the Entomological Society of Nova Scotia, has continued to publish important transactions. The Provincial Department of Agriculture for Nova Scotia contributed the sum of $300 in 1921 and $400 in 1922 towards assisting the society in its work, particularly in connection with its annual publications. These transactions contain very valuable contributions: the last number (No. 8) comprised 182 pages and had 25 full page plates of original figures.

The Halifax Institute of Science

Mr. Harry Piers has aided in no small way in the development of entomology in the province. As curator of the museum maintained by this society, he has been in a position to give information regarding insects, and in the Transactions of the Institute has published an important paper on the Orthoptera of Nova Socita, having been assisted in this publication by Mr. C. B. Gooderham, who at the time was attached to the Agricultural College at Truro, N. S.

NEW BRUNSWICK

Federal

In 1914, a small portable structure was used as the federal laboratory, space for which was provided on the grounds of the University of New Brunswick at Fredericton. The following year (1915) a permanent brick building of two stories was erected, an in 1917 an excellent insectary was added. The work at this laboratory was under the joint direction of Messrs. J. D. Tothill and L. S. McLaine, until 1918 when the latter officer was transferred to Ottawa.

The officers attached to the Fredericton laboratory have made special studies of the natural control of native insects and have also had charge of the introduction and establishment in eastern Canada of the parasitic and predaceous enemies of the Brown-tail and the Gipsy Moths. A bulletin on these two latter insects prepared by Messrs Tothill and McLaine was published by the Provincial Department of Agriculture in 1914. The natural control of the Fall Webworm, *Hyphantria cunea* Dru, the Forest Tent Caterpillar, *Malacosoma disstria* Hbn., and the Spruce Budworm, *Harmologa fumiferana* Clem. was specially studied by Dr. Tothill and his assistants. An important bulletin of 107 pages, entitled, "The Natural Control of the Fall Webworm" was published in 1922. In 1915, Dr. Tothill studied the natural control of the Oyster-shell Scale, *Lepidosaphes ulmi* L.; about 10,000 egg masses from several provinces were examined and it was found that the mite, *Hemisarcoptes malus* Shimer was the most important single factor in control. An investigation on the natural control of the White-marked Tussock moth, *Hemerocampa leucostigma* S. & A. was commenced in 1917, and the results published by Mr. A. G. Dustan in 1923. In the same year, a study of the natural control of the Cherry-tree Ugly-nest Tortricid, *Cacœcia cerasivorana* Fitch, was completed by Mr. A. B. Baird and a paper resulting therefrom published in 1918. More recently with the increase of the Larch Sawfly, *Lygœonematus erichsonii* Hartig.

in eastern Canada special life-history and parasite studies of the sawfly have been directed from the Fredericton laboratory.

The outbreak of the Spruce Budworm, *Harmologa fumiferana* Clem., first observed in New Brunswick in 1912, has been under continuous study by Dr. Swaine and Dr. Tothill, and in 1921-23, by Dr. F. C. Craighead of the Division of Forest Insects, Ottawa. Camps were established at Bathurst and other places during the progress of this investigation. Mr. M. B. Dunn of the federal staff, also assisted in this work. The natural control of the insect was specially studied by Dr. Tothill. The results of all of these spruce budworm studies are now being prepared for publication.

Following the inception of a close biological study of the Colorado Potato beetle, *Leptinotarsa decemlineata* Say, at Ottawa, in 1919, the bionomics of the insect in New Brunswick were undertaken by Mr. R. P. Gorham in 1921, and in this and following years much data was obtained.

In 1923, a reorganization of the staff employed at the Fredericton laboratory was effected, Dr. Tothill being transferred to the Division of Forest Insects, Mr. Baird to parasite studies at Ottawa, and Mr. Dustan to investigations relating to diseases of insects, in Nova Scotia. Mr. L. J. Simpson was retained at the Fredericton laboratory to assist Dr. Tothill. Insecticide investigations conducted from the Fredericton laboratory during 1922 and 1923 have been under the immediate charge of Mr. G. P. Walker. Control demonstrations in potato fields and in apple orchards have been of much value. In this work we have had the co-operation of the Superintendent of the Expermental Farm and, also, of the Provincial Horticulturist.

The federal fumigation station erected at St. John, N.B., in 1913, has during the period of this review, been in charge of Mr. H. E. Goold who has also assisted in the inspection of imported nursery stock. In 1923, this station was closed with the coming into effect of the revised regulations under the Destructive Insect and Pest Act. In order to assist, however, in the inspection of plant products arriving at the Port of St. John an office of the Entomological Branch was established there in 1923, Mr. Arthur Finnamore being placed in charge.

As in Nova Soctia, co-operative work in scouting for the nests of the Brown-tail moth, was conducted with the Department of Agriculture for New Brunswick. During the winter of 1913-14, as many as 28,100 nests were collected. In 1914-15, only 239 winter nests were found; in 1915-16, 395 nests; in 1916-17, 375 nests; and in 1917-18, 62 nests. Scouting carried on every winter since, has failed to find a single nest.

Provincial

For a number of years previous to 1923, Mr. William McIntosh, as Provincial Entomologist, published an annual statement discussing in brief the seasonal occurrence of injurious insects. Mr. McIntosh established an excellent connection with the school teachers of the province and this has enabled him to build up an extensive correspondence. He has, in addition, for some years taught nature study, including entomology, at the summer school for teachers conducted at Sussex, N.B. The Department has recently made a yearly grant of $200 to the Acadian Entomological Society.

Crown Lands Department.

Officers of this provincial Department have co-operated with entomologists of the federal service in forest insect survey work and other related investigations. In this connection Col. T. G. Loggie, the Deputy Minister, and Mr. G. H. Prince, the Chief Forester, have been active.

University of New Brunswick

During recent years an elementary course on forest insects has been given at the University of New Brunswick. This has been under the guidance of Professor A. V. S. Pulling. Dr. J. D. Tothill of the Dominion Entomological Branch has assisted in the course.

Other Activities

The Fredericton Science Club and the Natural History Society of New Brunswick have held lectures on various entomological subjects.

PRINCE EDWARD ISLAND

Federal

Officers attached to the Annapolis Royal, N.S., laboratory have on occasions, during recent years visited sections of the Island to investigate outbreak of grasshoppers and other insects. Much of the entomological work, howevers, has been conducted by correspondence. In 1918 insecticide investigations were conducted at Charlottetown, plots of potatoes for the purpose being placed at our disposal by the Superintendent of the Experimental Farm. Various dusts and sprays were used, the work being directed from the above laboratory. In 1923, Mr. J. A. Clark, Superintendent of the Farm, assisted our officers in connection with an outbreak of grasshoppers.

No provincial entomological service has been established.

QUEBEC

Federal

The federal laboratory at Covey Hill, Que. was moved to Hemmingford, in 1915. Mr. C. E. Petch who has been in charge of this laboratory has been engaged particularly in fruit insect investigations. Largely through his efforts, the proper spraying and care of orchard trees, as a means of protective them from insect pests, has been brought to the attention of the growers with excellent results. As an indication of the development in the sale of insecticides in Quebec province during recent years, Mr. Petch has given this subject special study, and from a statement he has given us, I have taken the following: Previous to 1911, Paris green was practically the only insecticide used in the province, but during the 10 years 1911 to 1921 there was a steady increase in the sale of

other insecticides. For instance, in the latter year, 194,000 pounds of Paris green were sold, and 80,600 pounds of other insecticides. The latter amount included, 60,000 pounds of arsenate of lead which up to 1918 had been used sparingly except in certain of the apple growing sections. The value of insecticides used by farmers of the province in 1921 was $175,000, according to Mr. Petch.

Special studies of the bionomics and control of the Apple Maggot, *Rhagoletis pomonella* Walsh, the Plum Curculio, *Conotrachelus nenuphar* Herbst., and the Apple Curculio, *Anthonomus quadrigibbus* Say, have been undertaken by the officer in charge of our laboratory at Hemmingford and the results of control studies have been demonstrated in commercial orchards. A practical apple-orchard spray calendar prepared by Mr. Petch, in collaboration with Mr. G. Maheux, the Provincial Entomologist, is being followed by many fruit growers of the province. Important data have also been secured on the value of dusting orchard trees and the spraying and dusting of potatoes. Demonstrations in the dusting and spraying of apple orchards in co-operation with the provincial Department of Agriculture, have been conducted in the important fruit centres. At the Hemmingford laboratory, too, investigations on live stock insects, particularly warble flies, have been undertaken. As mentioned in the report of the Dominion Entomologist for 1917 and 1918, "Cattle which were given the protection of an open shed during 1916, were found to be free from warbles in 1916, thus demonstrating the value of shade into which the warble flies appear to be disinclined to penetrate."

Forest insect investigations in Quebec province during the past ten years have made much progress. The outbreak of the Spruce Budworm, *Harmologa fumiferana* Clem., has enabled officers of the Division of Forest Insects, particularly Drs. Swaine and Craighead, to undertake intensive studies. Ground and air surveys of infested territory have been made and a mass of scientific data obtained and, as mentioned previously, much of this information will soon be published. In 1916, studies of dying spruce on the Black and Nation Rivers, were incepted by Dr. Swaine; the Four-eyed Spruce Bark-beetle, *Polygraphus rufipennis* Kby., being found to be directly associated with the injury. In 1917, a temporary forest insect laboratory was established at Fort Coulonge, Que., to investigate the life-histories and control of cerambycid and buprestid beetles. During recent years several summer camps for the study of forest insects have been established in Quebec province, as for instance at Lake Edward and Lac Tremblant, and a special study of the Destructive Eastern Spruce Bark-beetle, *Dendroctonus piceaperda* Hopk., in Quebec province is in progress. In the Gaspé area, valuable spruce stands are affected. Other important bark-beetles are also being investigated. A forest insect laboratory was erected at Aylmer, Que., in 1920, with Mr. C. B. Hutchings in charge. At this laboratory such important pests as the Bronze Birch Borer, *Agrilus anxius* Gory; the Oak Carpenter Worm, *Prion oxystus macmurtrei* Guer.; the Birch-leaf Skeletonizer, *Bucculatrix canadensisella* Chamb., etc., have been studied. Forest insect material is sent to this laboratory from the forests of Quebec and Ontario for biological studies.

During the year 1915, the writer directed a widespread grasshopper campaign in affected localities in Quebec province with the assistance of Messrs. Petch, Beaulieu and Beaulne, of the federal service, and resident parish priests. In all, 33,000 acres of growing crops (oats, hay, etc.), were treated with poisoned bait, as a result of which a reestablishment of agriculture in the infested regions was possible. This was the first large field crop control campaign

conducted in eastern Canada. The provincial Department of Agriculture made grants to the affected parishes, to assist the farmers in the purchase of bran, Paris green, etc.

In 1923, in co-operation with the Entomological Department of Macdonald College, investigations in truck crop insects were undertaken in the Montreal district, special attention being given to the control of the onion maggot, *Hylemyia antiqua* Meig.

In the development of the plant inspection service, an office of the Entomological Branch, was established in Montreal, in 1918, and for a number of years the work conducted from this office was in charge of Mr. J. I. Beaulne. This officer left our service in 1923, his place being taken by Mr. W. St. G. Ryan. With the coming into effect of the revised regulations of the Destructive Insect and Pest Act, in Sept. 1923, the fumigation station at St. John's, Que., was closed.

During the years 1922 and 1923, the Division of Foreign Pests Suppression undertook scouting work in the southern areas of Quebec province in order to see if the Gipsy moth had become established. In 1923, in view of the discovery of an important outbreak at Alburgh, Vermont, special scouting was undertaken in southern Quebec, particularly in the area adjourning that state. In this work, we were assisted by trained scouts, kindly loaned to us by the United States Bureau of Entomology.

Provincial

The provincial Department of Entomology was organized in 1914, in which year legislation for the "Protection of Plants from Destructive Insects and Fungoid Diseases", was passed. The Rev. Canon Huard was the first Provincial Entomologist and occupied the position form 1914 to 1915, in which latter year, Mr. George Maheux succeeded him. Mr. Maheux continues to direct in a very efficient manner the entomological activities of the Department. At first, nursery inspection was the work which chiefly occupied the time of the entomologist, but since 1916, the provincial activities have broadened considerably and under Mr. Maheux's direction valuable results have been accomplished. Much educational work has been undertaken, information relating to the control of insects being disseminated by means of lectures, bulletins, control demonstrations, spray calendars, etc. In this work, Mr. Omer Caron has assisted since 1921.

Nurseries in the province are inspected at regular intervals. During the last four years special demonstrations in spraying have been given each year on 160 farms. In addition, similar demonstrations have been given on 60 fruits farms, 40 vegetable plots and 60 small fruit plantations. The work on some of the larger fruit farms has been carried on in close co-operation with the Dominion Entomological Branch. County entomological work was started in 1922, with an officer in charge. Control demonstrations have been carried out with such insects as grasshoppers, root maggots, tent caterpillars, cutworms, potato beetle, etc., and all of this work has convinced the farmers of the efficiency of the measures of control. In 1918, the existing legislation was amended, giving the Provincial Executive Council authority to take action against any pest when deemed necessary. In 1920, the legislation of 1909, relating to "The Protection of Bees", was amended to increase the fine to be paid by any person who sprays fruit trees in bloom.

Macdonald College

In 1914, the entomological staff at Macdonald College consisted of Prof. W. Lochhead, Mr. E. M. DuPorte, and Mr. P. I. Bryce. Mr. DuPorte devoted a large portion of his time for six years to research, but gave a few lectures on special topics to advanced students. In 1920, on the departure of Mr. Bryce, he was appointed Lecturer, and his time has been largely devoted to advanced classes. During this period, he published a number of important papers, such as, "The Nervous System of *Sphida obliqua*"; "Death-feigning Reactions on *Tychius picirostris*"; "The Life-history and Control of the Bud Moth"; "The Structure and Functions of the Proventriculus of *Gryllus*"; "The Propleural and Pronotal Sulci in the Orthoptera"; "Studies of *Coccobacillus acridiorium* and other Intestinal Organisms of Locusts"; "The Muscular System of *Gryllus assimilis*"; "Studies of *Spirochaeta duttoni*", and various shorter papers on economic subjects.

In 1919, Prof. Lochhead published his "Class Book of Economic Entomology" (Blakistons) which is used in a number of educational institutions. He has also contributed many papers on entomological subjects to the Annual Reports of the Entomological Society of Ontario, the Quebec Society for the Protection of Plants, and the Pomological Society of Quebec; and to "The Journal of Agriculture", and other publications. A number of circulars have also been prepared for the use of Quebec orchardists and gardeners.

Among the economic insects the life-histories of which have been studied are:—the Bud Moth, the Onion Maggot, flea beetles, and the control of grasshoppers.

At the present time, the entomological staff consists of Prof. Lochhead, Dr. E. M. DuPorte, and Mr. A. D. Baker. An important feature of the instruction is the attention given to post-graduate students working for the Master's degree. The large amount of time and energy required for class-room work on the part of the staff has necessarily limited the length of time that could be devoted to economic studies.

Agricultural College, Oka.

At this institution, the position of Professor of Entomology was established in 1915, and Prof. F. Letourneau received the appointment. Courses in entomology were developed and, in addition, instruction in field work was given. In all of this work, Father Leopold has undoubtedly been the guiding hand, the investigations of the latter, particularly with regard to spraying problems, having been most valuable.

Montreal Entomological Society (Montreal Branch of the Entomological, Society of Ontario)

In 1923, this society celebrated its fiftieth annual meeting. During the years under review regular meetings have been held at which papers were presented and specimens exhibited. The society has, indeed, an enviable record. In its continued progress, Messrs. A. F. Winn and G. A. Moore have taken a leading part.

Lyman Request Committee.

Under the terms of the will of the late Henry H. Lyman, of Montreal, who died in 1914, his entomological collections and library with a sum of money for their upkeep, were bequeathed to McGill University. These bequests were accepted by the University authorities, and in due course a room in the Redpath Museum was allotted for them housing of the collection and library. The Dominion Entomologist is a member of the Committee in charge. During the last ten years the collection and library have been considerably added to, and the general curatorship of them has been undertaken by Mr. A. F. Winn.

The Quebec Society for the Protection of Plants.

This society, established in 1908, has continued to hold its annual meetings at Macdonald College, at which valuable papers on entomological subjects have been presented. These contributions have been duly published in the excellent series of yearly reports issued. The society has certainly accomplished much useful work and the gatherings held under its auspices and the resultant publications have been of direct benefit to farmers, fruit growers, gardeners and others.

Other Activities

Since 1914, limited courses in entomology have been given at the Laval Forest School and at the Agricultural School at Ste-Anne de la Pocatière. At the latter school, the position of Professor of Botany and Entomology, 1914-1923, was occupied by Mr. George Bouchard.

The 25th anniversary of the Abbé Provancher's death was celebrated in Quebec city, in 1918, and a bronze tablet was erected to his memory in the Provincial Museum. In the following year, the Society Provancher d'Histoire Naturelle was founded, its aim being to assist in general zoological studies, more particularly, however, in endeavors such as those fostered by the American Audubon Society.

ONTARIO

Federal

With the separation of the entomological service from the Experimental Farms Branch in 1914, the Entomological Branch thus constituted, was given quarters in the Birks Building, Ottawa, and now occupies the two upper floors of this building. The Divisional organization of the Branch has been referred to in the beginning of this review

The Branch in addition to the Ottawa laboratories and insectary, maintains two permanent laboratories in Ontario, namely, at Vineland Station and Strathroy; and two temporary laboratories, namely, at Port Stanley and St. Thomas.

The work of the officers resident at Ottawa, has, in general, been referred to. Mention however, might, briefly be made here of certain special investigations conducted in the Ottawa district. In 1914 and 1915, grasshopper control experiments were conducted by the writer near Bowesville. In the

latter year the Lesser Migratory Grasshopper, *Melanoplus atlanis* Riley was enormously abundant and, to a lesser extent the Pellucid Grasshopper, known in the west as the Roadside Grasshopper, *Camnula pellucida* Scudd. In these experiments the value of sawdust as a carrier for poison in bait mixtures was demonstrated under field conditions. In 1915, Circular No 5—"The Control of Locusts in Eastern Canada" was published and given wide publicity. For a number of years, the Cabbage Root maggot, *Hylemyia brassicae* Bouché was studied and the results published (1906) in Bulletin No 12, prepared jointly by the writer and Mr. R. C. Treherne. Since the appearance of this bulletin, frequent demonstrations have been given in the Ottawa district, proving the value of the corrosive sublimate remedy, which has now been widely adopted by commercial growers not only in Canada but also in the United States.

In 1919, an intensive study of the Colorado Potato beetle was planned by the writer and incepted at Ottawa, with the assistance of Mr. J. A. Flock. This study has been continued at Fredericton, N. B., by Mr. R. P. Gorham, and at Strathroy, Ont., by Mr. H. F. Hudson. Much valuable data have been obtained, which it is hoped to publish in the near future.

White grubs have also been investigated, life-history notes on the following species having been obtained: *Lachnosterna fusca* Froel., *L. anxia* Lec. and *L. drakei* Kby. In this work Mr. H. G. Crawford assisted.

The value of aerial surveys in forest insect investigations was demonstrated in 1920, when Dr. J. M. Swaine and Mr. M. B. Dunn made aeroplane flights in Spruce Budworm-infested districts in Northern Ontario, especially between Lakes Temiskaming and Temagami. In the same year two forest sample plots were established on the shores of Lake Abitibi.

The results of Dr. Swaine's studies of Canadian Bark-beetles were published in 1917 and 1918; Part 1, Descriptions of New Species-in the former year; and Part 2-A Preliminary Classification, with an account of the Habits and Means of Control, in the latter year. This publication of 143 pages, (Bulletin No. 14) has received widespread favour from entomologists and foresters. During recent years Dr. Swaine and Mr. Ralph Hopping have made special studies of groups in the family Cerambycidae and an important paper on the Lepturini of North America has been completed.

Mr. L. S. McLaine, Chief of the Division of Foreign Pests Suppression, has been accumulating, at Ottawa, an interesting collection of insects found on imported plant products. Largely through the efforts of Mr. R. C. Treherne, Chief of the Division of Field Crop and Garden Insects, "The Canadian Insect Pest Review" was established in April, 1923. This is a manuscript publication prepared especially for the information of federal workers. Mr. C. R. Twinn has assisted in the preparation of this review.

For several years the same Division has prepared statements on insect conditions for publication in the monthly "Fruit and Vegetable Crop Report" published by the federal Fruit Branch.

The Vineland laboratory which is in the main building of the Vineland Horticultural Station and has been under the continuous direction of Mr. W. A. Ross; an excellent insectary was erected in 1919. Mr. Ross during the past ten years has established a close connection with the growers of the Niagara Penninsula, and the result of the work undertaken has been of great value to the district. The life-histories of such important pests as the Pear Psylla, *Psyllia pyricola* Forst.; the Apple Maggot *Rhagoletis pomonella* Walsh.; the Potato Leaf-hopper, *Empoasca mali* Le B.; the Plum Spider Mite, *Paratetranychus pilosus* C. & F.; the Grape Leaf-hopper, *Erythroneura comes* Say;

the Rose Chafer, *Macrodactylus subspinosus* Fab.; the Black Cherry aphis, *Myzus cerasi* Fab.; the Strawberry Weevil, *Anthonomus signatus* Say; the Rose Midge, *Dasyneura rhodophaga* Coq.; the blackberry Leaf-miner, *Matallus bethunei* MacG., and others, have been worked out and improved methods of control established. Much extension work has also been conducted from this laboratory and demonstrations in spraying and dusting under commercial conditions have been given each year in a number of important sections. Mr. Ross has also devoted much time to a systematic study of the family Aphididae. In May, 1919, an illustrated bulletin on the Apple Maggot, prepared jointly by Prof. L. Caesar and Mr. Ross was published by the Ontario Department of Agriculture. At the Vineland laboratory, Mr. Ross has been assisted by Messrs. C. H. Curran, W. Robinson, W. P. Garlick and J. A. Hall.

During the absence on military service of Mr. H. F. Hudson, Mr. J. R. Gareau was placed in charge of the Strathroy laboratory, in 1915; his chief investigations related to white grubs. During the summers of 1916 and 1917, Mr. H. G. Crawford was employed temporarily at Strathroy to extend these investigations owing to the continued absence of Mr. Hudson. In 1918, the temporary portable laboratory at Strathroy, was replaced by a permanent structure, Mr. H. F. Hudson continuing in charge. At this laboratory field crop insects have been given special study. White grubs, *Lachnosterna* spp., as already mentioned, have received particular attention and the habits and life-histories of several important species have been worked out. Much new information has also been obtained on the Colorado Potato Beetle, *Leptinotarsa decemlineata* Say; the Hessian Fly, *Phytophaga destructor* Say; the Clover Leaf Weevil, *Hypera punctata* Fab.; the Army Worm, *Cirphis unipuncta* Haw., etc. Recently Mr. Hudson has also assisted in European Corn Borer studies in western Ontario. In 1914, there was a very severe outbreak of the Army Worm in Ontario, damage to the value of $250,000, being effected to growing crops. Mr. Hudson took a prominent part in the control campaign and, in co-operation with officials of the Ontario Department of Agriculture, rendered valuable aid in saving considerable acreages of crops. The trench method of control was the one specially demonstrated. An account of this work is published in Entomological Bulletin No 9, which appeared in 1915.

Following the discovery of the European Corn Borer, *Pyrausta nubilalis* Hbn., in 1920, by Messrs. Keenan and Simpson, a temporary field laboratory was established at Port Stanley in the spring of 1921, Mr. H. G. Crawford, of the Division of Field Crop and Garden insects being placed in charge. The scouting work conducted during the previous year by the Division of Foreign Pests Suppression in co-operation with the Provincial Department of Agriculture, revealed that seven counties were infested by the borer. In the latter year, biological investigations were incepted and methods of control studied. These studies are still being continued and much success has attended the efforts of our officers. In all of this work we have been closely associated with provincial officials and also with officers of the United States Bureau of Entomology. At the conclusion of the scouting work in 1923, 21 counties in Ontario were known to be infested, the important infestations, remaining, as in 1921, in Elgin and Middlesex counties and the Entomological Branch has maintained quarantines on all such counties. The Port Stanley laboratory has served as the headquarters for those engaged in scouting for the corn borer, Mr. W. N. Keenan having the immediate direction of this latter work, assisted by Messrs. L. J. Simpson and C. R. Twinn. In the biological and control investigations, Mr. Crawford has been assisted by Mr. R. H. Painter.

A temporary Corn Borer parasite laboratory was established at St, Thomas in 1923, with Mr. A. B. Baird in charge. In May of that year, a small breeding stock of the European parasite, *Habrobracon brevicornis* Wesm., was presented to us by the United States Bureau of Entomology. During the season fairly strong colonies of the parasite reared in the laboratory were liberated in important corn borer infested fields, over 600,000 individuals of the parasite being released altogether. Several native parasites which attacked the corn borer have also been under observation. In this work, Mr. Baird has been assisted by Mr. H. G. Dyce.

In 1922, a plant inspection office was established in the Customs Examining Warehouse, Toronto, Mr. W. A. Fowler in charge, and with the coming into effect of the revised regulations under the Destructive Insect and Pest Act, in Sept,. 1923, the fumigation stations at Niagara Falls and Windsor, were closed, but the station at Montrose was retained. In the same year, an inspection office was opened at Niagara Falls, Mr. R. W. Sheppard in charge, and an inspection service established at Windsor, Ont., Mr. C. S. Thompson in charge.

Provincial

The Provincial Entomologist, Prof. L. Caesar, has continued, since 1914, to direct the provincial entomological work, and his investigations have added very materially to the knowledge of several of our important insect pests.

Bulletins on such insects as the Cherry Fruit Fly, *Rhagoletis fausta* O. S., the Apple Maggot, *Rhagoletis pomonella* Walsh., and the Cabbage Maggot, *Hylemyia brassicae* Bouché, have been prepared by Prof. Caesar and these present original data both as regards the biology of the insects and their control. In addition to these publications the Department has continued to include in its Annual Reports notes on entomological work conducted under the direction of Prof. Caesar. Mr. A. H. McLennan, as the Ontario Vegetable Expert, conducted educational work, particularly in regard to the control of the Cabbage Maggot.

During the summer months, inspectors of the Department visit nurseries in Ontario, particularly in districts where the San José Scale is present. In 1920, 1921 and 1922 provincial inspectors also co-operated with the Dominion Entomological Branch in the Corn Borer scouting work in the Province of Ontario. For a number of years, too, the Department has assisted the federal Department in the inspection of imported nursery stock.

The Department continues to publish the Annual Reports of the Entomological Society of Ontario and also to grant to the Society, annually, the sum of $1,000.

Since the appearance of the European Corn Borer, in western Ontario, a laboratory has been established near Port Stanley, Ont., with Mr. G. J. Spencer in charge. At this laboratory the life-history of the Corn Borer and means of control have been studied. The whole problem in general has been investigated in close co-operation with the officials of the Dominion Entomological Branch and as a result of this co-operation a bulletin on the corn borer recently appeared under the authorship of Messrs. G. J. Spencer and H. G. Crawford.

Ontario Agricultural College

At the Ontario Agricultural College, the staff of the Entomological Department in 1914 consisted of Dr. C. J. S. Bethune, Professor of Entomo-

logy and Zoology; L. Caesar, Associate Professor; A. W. Baker, Lecturer and G. J. Spencer, Demonstrator. To-day it is comprises of : L. Caesar, Professor of Economic Entomology; A. W. Baker, Professor of Systematic Entomology and Zoology; G. J. Spencer, Lecturer, and J. A. Flock, Demonstrator. Dr. Bethune retired from active entomological work in 1921 ; no one in Canada has been more keenly interested in the development of applied entomology than he. His life has certainly been a most useful one and it is a great pleasure to us in Canada to know of the wide esteem in which he is held by entomologists the world over.

During the years covered by this review, many students at Guelph have decided upon entomology as their life's work. Some of these have accepted positions outside of Canada where they are making excellent reputations; others have entered federal or provincial services where they are establishing splendid records.

Professor Baker has made special studies of live stock insects and has also been much interested in the Mallophaga. In 1919, he studied the Mallophaga collected by the members of the Canadian Arctic Expedition (1913-1918), and this was published as Part D, of Volume III, on Insects.

Entomological Society of Ontario

This well known society has continued to aid to a marked degree the development of applied entomology in Canada. Since 1914, the Annual Reports of the Society have been published each year. These contain papers of considerable value. The parent society with headquarters at the Ontario Agricultural College has held series of winter meetings and these have been of special benefit to students attending the college. The branches of the society in Nova Scotia, Quebec and British Columbia, have also been active.

The Canadian Entomologist, published by the society has been issued regularly and with the close of 1923, Volume LV was completed.

University of Toronto

A course in forest entomology, has been given during recent years at the University of Toronto, by Professor E. M. Walker. Dr. Walker too, has continued his studies in Orthoptera, and Dr. W. A. Clemens, while attached to the University staff, made valuable investigations of ephemerid and other insects as a source of food for fishes.

MANITOBA

Federal

Mr. Norman Criddle has continued in charge of the work conducted from the laboratory at Treesbank. The original building erected in 1915, although small, was the home of much original research. In 1923, a larger permanent structure was erected. Mr. Criddle's investigations have related very largely to insects attacking grain crops. Studies of white grubs, begun in 1914, continued to occupy much of his time, and life-history data on the following species have been obtained: *Lachnosterna rugosa* Welsh, *L. anxia* Lec., *L nitida* Lec. and *L. drakei* Kby. The Western Wheat-stem sawfly, *Cephus cinctus* Nort. and the Hessian Fly, *Phytophaga destructor* Say, have been under special observation

for years, and in 1915 a bulletin discussing the habits and control of these two pests was published. A further pamphlet on the former insect was distributed in 1922 and one on the latter in 1923. In connection with studies of the Western Wheat Stem-sawfly, it was noted by our officers and also by provincial officers, that the larva of the sawfly does not cut the stems until the plants begin to lose their sap. The early cutting of grain, therefore, was recommended and this has meant savings amounting to many hundreds of thousands of dollars. In 1915, and later years, Mr. Criddle made large collections of the adults of the grass stem maggots, (Oscinidae) which were determined by Dr. J. M. Aldrich, of the United States Bureau of Entomology. Much valuable data were thus secured on the distribution of these insects. Several species of these flies were also reared from wheat, rye, corn and barley.

The recent outbreak of grasshoppers in the prairie provinces, was first investigated, in Manitoba, by Mr. Criddle, in 1919. The prevalent species were the Roadside Grasshopper, *Camnula pellucida* Scudd, and the Lesser Migratory Grasshopper, *Melanoplus atlanis* Riley. According to Mr. Criddle the outbreak in Manitoba was the worst of which he had record since 1875. The total area infested was more than 500,000 acres. Early in 1920, a circular entitled "Locust Control in the Prairie Provinces" was prepared by Mr. Criddle and given wide circulation. In this year, the infestation covered a wider area than that of 1919. In 1920, it was estimated that the co-operative efforts of provincial and federal entomologists resulted in the saving of crops worth $17,000.000. Experiments with poisoned baits consisting of sawdust of any kind mixed with an equal quantity of bran were entirely successful and considerably reduced the cost of control. A further reduction in the cost resulted from the use of salt as an attractant instead of the more expensive molasses and lemons. In 1921, Mr. Geo. E. Sanders, in charge of insecticide investigations, was detailed to Manitoba to assist in experimental work with poisoned baits, and a temporary laboratory was established at Souris. Much data regarding various attractants, etc., were obtained. This was a continuation of similar work undertaken in Saskatchewan in 1920. During the summers of 1920 and 1921, Mr. P. N. Vroom was transferred to Treesbank, to assist Mr. Criddle in grasshopper investigations.

Studies of various species of cutworms and other important field crop insects have also been made by Mr. Criddle as time permitted. Live stock and shade tree insects have also had his interest. During the last few years one of his assistants, Mr. H. A. Robertson, has undertaken a study of the mosquitoes of Manitoba.

Few serious outbreaks of forest insects have occurred in Manitoba during the last decade. The Larch Sawfly, *Lygaeonematus erichsonii* Hartig., has increased in numbers and in some sections has effected important injury. In 1922, Dr. Swaine studied an outbreak of the Destructive Spruce Bark-beetle, *Dendroctonus piceaperda* Hopk., affecting white spruce, in the province.

Parasitized cocoons of the Larch Sawfly imported from England, by the late Dr. Hewitt, were distributed in larch stands in Manitoba in 1912 and 1913, east of Cedar Lake and near Aweme. In the spring of 1916, Mr. Criddle visited the latter area and from a collection of 514 cocoons, reared 27 specimens of the European parasite *Mesoleius tenthredinis* Morley, thus indicating that the species had become established in that locality.

With the coming into effect of the revised regulations under the Destructive Insect and Pest Act, in Sept. 1923, the fumigation station at Winnipeg was closed.

Provincial

Under the direction of Mr. J. H. Evans, Deputy Minister of Agriculture, the Department has been actively engaged in an important grasshopper campaign during recent years as a result of which millions of dollars worth of crops have been saved to the farmers. In this connection, Mr. A. V. Mitchener has given me the following notes: "In a province where federal and provincial officers have worked as harmoniously as they have in Manitoba, it is impossible and undesirable to ascribe entire credit for any achievement to provincial authorities. The local Department of Agriculture possibly inaugurated one of the first wholesale campaigns against grasshoppers put on in Canada. The successful issue of this campaign was largely made possible through the effort of the federal entomological field officer, Mr. Norman Criddle, whose suggested changes in the bait used, very materially lessened the cost of the campaign. In this campaign a homemade machine for mixing grasshopper baits in large quantities was developed and was given the name of the "Manitoba Mixer". The Department of Agriculture, in co-operation with the Dominion Entomological Branch, has also conducted important work in connection with investigations relating to the control of the Western Wheat Stem-sawfly Recommendations that wheat be cut early to avoid loss from sawfly injury has saved many thousand of bushels of wheat for the farmers."

On March 27, 1920, "An Act to Amend 'The Municipal Act' was assented to (Chapter 82 of 10 George V, Statutes of Manitoba). This Act included the following regarding grasshoppers: "The council of a municipality may, by resolution supported by two-thirds of its members, institute measures for the destruction and control of grasshoppers or other insect pests injurious to crops, and may vote out of the general revenue of the municipality such sum or sums as may be required for the purpose."

Manitoba Agricultural College

In the province of Manitoba previous to 1918, instruction in entomology at the Manitoba Agricultural College was given by Professor F. W. Broderick and Mr. J. A. Neilson of the Department of Horticulture. In May, 1918, Mr. A. V. Mitchener was appointed lecturer in Entomology, but his title has since been changed to Assistant Professor of Entomology.

Natural History Society of Manitoba

This society has of recent years been devoting considerable attention through its Entomological Section to the study of insects, chiefly under the leadership of Mr. J. B. Wallis. The society has published a "Key to Manitoba Butterflies", by Mr. Wallis, and Messrs. Criddle and Wallis have in preparation a "List of Manitoba Coleoptera."

SASKATCHEWAN

Federal

In 1918, through the courtesy of President Murray of the University of Saskatchewan, Saskatoon, accommodation was granted for the establishment of a Dominion entomological laboratory, and Dr. A. E. Cameron was appointed

entomologist-in-charge. During the previous year, Dr. Cameron in co-operation with Dr. S. Hadwen, then pathologist of the federal Health of Animals Branch, incepted a joint study of the bot fliesaffecting horses, the results of which were published in *The Bulletin of Entomological Research*, Vol. IX, No. 2, 1918. In the same year, Dr. Cameron began studies of other blood-sucking diptera, such as mosquitoes, tabanids and black flies. In 1918, too, a remarkable outbreak of the Sugar-beet Webworm, *Loxostege sticticalis* Linn., occurred in the Prairie provinces, particularly in Saskatchewan where millions of migrating larvae caused widespread alarm. The outbreak of grasshoppers (*Camnula pellucida* Scudd, and *Melanoplus atlanis* Riley), in 1919, which involved an area of approximately 1500 square miles, was investigated by Dr. Cameron and Mr. M. P. Tullis, of the Provincial Department of Agriculture. This outbreak is discussed in Entomological Circular No 13. In the following year the province was again subjected to a serious grasshopper infestation and, as I mentioned in my annual report for the two years ending March, 1921, in regard to poisoned bait, "sawdust was employed to a considerable extent. To the Entomological Branch belongs the credit of first demonstrating under large acreage conditions the value of sawdust as a cheap carrier for poison." In this year (1920), Mr. A. Kelsall (Insecticide Investigations) spent the greater part of the months of June and July in the neighborhood of Carlyle, Sask., in order to investigate further the value of various poisons for killing grasshoppers and dust mixtures, contact sprays, poison gas and poisoned baits were experimented with. A brief account of this work is given in the report referred to above. Officers of the Branch have kept in close touch with provincial officers during the whole of the recent grasshopper campaign.

Dr. Cameron's permanent appointment with the Branch terminated in October, 1920, but in the summer of 1921, pending the appointment of a successor, he was re-employed at Saskatoon. Mr. K. M. King was appointed in August, 1922, as entomologist in charge of the laboratory. Since his appointment he has been specially interested in soil-infesting insects, particularly cutworms and wireworms. In 1923, he incepted a series of soil faunal studies in co-operation with the Departments of Field Husbandry and Physics of the University of Saskatchewan. In the same year, an outbreak of the North-West Chinch Bug, *Blissus occiduus* Barber, closely allied to the true Chinch Bug, was investigated by Mr. King in the vicinity of Lacadena.

Previous to the establishment of a permanent laboratory at Saskatoon, Mr. Norman Criddle, in charge of the Treesbank, Man., laboratory, assisted materially in entomological investigations in the province. In 1915, he studied the outbreak of the Red-backed Cutworm, *Euxoa ochrogaster* Gn., which infested territory extending from Selkirk in Manitoba to Fort Pitte and Lloydminster on the western boundary of Saskatchewan. In the vicinity of Wadena, Sask., it was estimated that 3,000 acres of crop were damaged, of which 1750 acres were totally destroyed. In 1916, Mr. Criddle noted the spread of the Western Wheat-stem Sawfly into that portion of Saskatchewan adjoining the south western region of Manitoba.

The Division of Forest Insects have investigated outbreaks of forest insects particularly in Northern Saskatchewan. In 1922, Dr. Swaine visited the spruce areas along the lower Saskatchewan river and on the Porcupine Forest Reserve. Extensive outbreaks of the Destructive Spruce Bark-beetle, *Dendroctonus piceaperda* Hopk., were investigated and the Larch Sawfly was noted to be increasing in the areas visited. In 1923, Mr. Norman Criddle,

investigated a rather serious outbreak of one of the tent caterpillars, (*Malacosoma* sp.) particularly on the Moose Mountain Reserve, where aspen poplars, especially, were defoliated. In the same year, Mr. J. J. de Gryse was appointed to take charge of shade tree insect investigations in the Prairie Provinces and with the interest and co-operation of Mr. Norman M. Ross, Chief of Tree-planting Division, Dominion Forestry Branch, a temporary laboratory was established on the Forestry Station at Indian Head. Mr. de Gryse, visited also, later in the year, the Moose Mountain area infested by tent caterpillars. An excellent start has been made in shade tree insect investigations and Mr. de Gryse has already accumulated much data of value.

With the coming into effect of the revised regulations of the Destructive Insect and Pest Act, Sept. 1, 1923, the fumigation station at North Portal was closed.

Provincial

During the last decade, Mr. M. P. Tullis, Field Crops Commissioner, has aided very materially in entomological control work in the province and he has been chiefly responsible for the recent very successful grasshopper campaign The following quotation is from his report for 1923. "In 1919, forty-six rural municipalities were infested. Unfortunately, 90,000 acres of crop were destroyed, but as a direct result of the campaign 120,000 acres were saved. In 1920, the outbreak was more serious, and ninety-seven rural municipalities were involved. However, the campaign was more highly organized and 1,400,000 acres of infested crop were saved, while only 45,000 acres were destroyed. In 1921, the same methods of organization were employed, and ninety-five rural municipalities fought the grasshoppers. 1,960,000 acres of infested crop were saved and 93,000 acres destroyed. In 1922, one hundred and thirty-seven rural municipalities were affected; 640,000 acres were saved and 23,000 acres destroyed.

Reviewing the situation during the last four years it is found that grasshoppers have cost the sum of $742,535.35 in supplies alone, assuming that in 1919 the municipalities paid out a sum equal to that spent by this Branch. The total number of acres of infested crop saved in the four campaigns is 3,256,000, and the acreage destroyed is 251,000."

University of Saskatchewan

With the appointment of Dr. A. E. Cameron, of the Dominion Entomological Branch, as Professor of Zoology and Entomology in 1920, the University took a more active interest in entomological research and education. In the University courses of instruction, Dr. Cameron has given the entomological lectures and directed the laboratory work. He has also continued his research work particularly in the dipterous family Simuliidae. In 1923, Dr. Seymour Hadwen, lately of the federal service, Ottawa, was appointed Research Professor of Animal Pathology. Dr. Hadwen is continuing entomological work, his interest being largely in insects affecting live stock before taking up his duties at Saskatoon, he prepared a bulletin concerning which, which was published by the Dominion Entomological Branch.

ALBERTA

Federal

The Entomological Branch laboratory at Lethbridge, established in 1913, was closed during 1917 and 1918, owing to Mr. E. H. Strickland's absence in Europe on military service. With Mr. Strickland's return to Canada, the laboratory was again placed under his charge in 1919, and 1920, and during the winter months, at Ottawa, he undertook studies of stored product pests. In March, 1921, Mr. H. L. Seamans, was appointed entomologist at Lethbridge.

In 1915, a new permanent laboratory was erected on the Dominion Experimental Station and adjoining space furnished for experimental purposes. The intensive study of the life-habits and control of the Pale Western Cutworm, *Porosagrotis orthogonia* Morr., incepted by the writer in 1913, in association with Mr. Strickland has continued to be the major project at the Lethbridge laboratory. The information gained by Messrs Strickland and Seamans has been of great value in infested districts.

In 1915, the first extensive outbreak in Canada of the Army Cutworm, *Chorizagrotis auxiliaris* Grt., occurred in Alberta covering an area of about 3,000 square miles. A bulletin giving the results of Mr. Strickland's researches was published in 1916. In the same year an entomological survey was made in the Lesser Slave Lake region in Northern Alberta by Messrs. Swaine and Strickland and important data obtained particularly on forest and field crop insects.

The 1919 outbreak of grasshoppers to which reference has been made under the provinces of Manitoba and Saskatchewan, was also serious in Alberta, particularly in areas west and south of Lethbridge. Mr. Strickland continued to direct the grasshopper campaign in 1920 and as a result of his work, crops to the value of over one million dollars were saved to farmers who followed our recommendations. Since 1920, the control of grasshoppers has continued to occupy much of the time of our officers. A study of alfalfa insects has also been incepted. The Alfalfa Thrips, *Frankliniella occidentalis* Pergande, in 1921, destroyed 80% of the buds of alfalfa. Mr. Seamans' studies have shown that an early "clipping" of alfalfa late in May will check the development of the insect to a material extent. In all of the work at the Lethbridge laboratory, we have had the close co-operation of Mr. W. H. Fairfield, Superintendent of the Experimental Station.

During his engagement, Mr. Strickland conducted important researches in the biology of parasites of prairie cutworms, much of the results of which have appeared in Entomological Bulletin No. 22 entitled "Biological Notes on Parasites of Prairie Cutworms."

In 1916, the late Dr. Hewitt spent most of the month of July, at Banff, Alta, for the purpose of investigating the problem of mosquito control within the district. From collections and rearings made, much valuable information was obtained, which constituted the foundation for further intensive work undertaken in 1922. In 1921, Mr. Eric Hearle and the writer made a survey of the important breeding places, and in the following year, in close-co-operation with the Dominion Parks Branch, a temporary laboratory was erected in the Rocky Mountains Park, with Mr. Hearle in charge. As a result of the control work conducted in 1922 and 1923, there has been a marked decrease in the numbers of mosquitoes present during the tourist season. Previous to 1922,

Mr. N. B. Sanson, Curator of the Banff Museum, had conducted some control work but little biological work had been attempted.

As this latter museum, Mr. Sanson has brought together a general collection of the insects of the Rocky Mountains Park.

In 1915, Dr. Swaine of the Division of Forest Insects visited the Lesser Slave Lake region in northern Alberta, for the purpose of investigating forest insect injuries. Infestations of the Destructive Spruce Bark-beetle, *Dendroctonus piceaperda* Hopk., and the Western Balsam Bark-beetle, *Dryocoetes confusus* Sw., were located. In the same year the valuable forests of the Rocky Mountains Park, Banff, were examined with a view to furnishing advice on their protection. Special studies of forest insect injury, particularly to pine, were made in 1919, by Dr. Swaine in the Jasper National Park. The tr ees showed characteristic evidence of mistletoe attack followed by various species of *Ips*. In 1923, the Division of Forest Insects, reported that the Larch Sawfly had defoliated larch trees west of Edmonton. Correspondents of the Branch also reported injury in sections north and west of Edmonton.

During the summers of 1922 and 1923, the Division of Foreign Pests Suppression undertook scouting for the Alfalfa Weevil, *Phytonomus posticus* Gyll in southern Alberta. In 1922, 286 farms were visited and a large number of sweepings made from fields of alfalfa. During the following year (1923), 491 farms were visited and sweepings made from 542 fields of alfalfa. As yet no sign of the Alfalfa Weevil has been discovered in western Canada.

Natural control studies particularly of the Fall Webworm, *Hyphantria cunea* Dru., and the Tent Caterpillar, *Malacosoma disstria* Hbn., were made in British Columbia and Alberta in 1917 and 1918 by Messrs Tothill and Baird. In the latter year, Mr. Baird spent about six weeks in the neighborhood of Sylvan Lake.

In October, 1923, the Entomological Branch was allotted two rooms in the Post Office Building in Lethbridge. These will be used for laboratory purposes especially during the winter months.

Provincial

No official with the title of Provincial Entomologist has so far been appointed. Mr. Donald Mackie of the Department of Agriculture conducted entomological correspondence for a number of years and gave advice regarding the more common insect pests of the province. During recent years particularly in connection with the grasshopper campaign, Professor E. H. Strickland of the University of Alberta, Mr. H. A. Craig, Deputy Minister and Mr. Z. W. MacIlmoyle, Assistant Deputy Minister, of the Department, have rendered much assistance to the farmers in insect control work.

In 1922, the province passed "An Act to provide for the Extermination of Agricultural Pests." This legislation gave the Department of Agriculture power to take such action as it thought desirable in the control of pests of grain or other crops and a separate part of the Act dealt particularly with grasshopper control. In 1921, a circular on grasshopper control prepared by Messrs. Strickland and Seamans was published by the Department.

University of Alberta

Mr. E. H. Strickland of the Dominion Entomological Branch was appointed in 1922, to the newly created position of Professor of Entomology in the

University and since then he has, in addition to teaching entomology, endeavoured to build up a working collection of the insects of the province and also a general consulting library. In his new field of labour he has already made interesting progress and in economic problems of importance has continued to aid federal work in addition to directing provincial activities.

The Alberta Natural History Society.

Since 1914, this society has continued to publish in the Annual Report of the Department of Agriculture a statement regarding insects of the season. This report has in the main been prepared by Mr F. C. Whitehouse. In addition to this annual statement the society has published the following important lists: "Dragonflies (Odonata) of Alberta, by F. C. Whitehouse, issued May, 1918; "Annotated Check List of the Macrolepidoptera of Alberta", by K. Bowman, issued February, 1919, and "Annotated List of Coleoptera of Northern Alberta", by F. C. Carr, issued August, 1920.

BRITISH COLUMBIA

Federal

In 1914, the Entomological Branch had its headquarters in the Province of British Columbia, at Agassiz, with Mr. R. C. Treherne in charge. In that year investigations chiefly related to root maggots, wheat midge and insects affecting fruit particularly in the Lower Fraser and Okanagan Valleys. Bulletin No. 8, on the Strawberry-root Weevil, by Mr. Treherne was published in 1914, and in the same year Bulletin No. 7 on "Forest Insect Conditions in British Columbia", by Dr. Swaine, was also published. In 1914, too, a temporary forest insect laboratory was established in Stanley Park, Vancouver, with Mr. R. N. Chrystal in charge. Spruce gall aphids, the Hemlock Looper, (*Ellopia* sp.) and bark-beetles were especially investigated. In 1915, this work was continued, and in the same year, Dr. Swaine visited the National Parks at Glacier and Field to examine forest insect prevalence. The Stanley Park laboratory was closed in 1917, when Mr. Chrystal returned to Ottawa to undertake studies of scale insects in general and also certain shade tree insects.

The Cabbage Root Maggot project engaged most of Mr Treherne's time, in 1915, at Agassiz, and much valuable work was accomplished. In view of the discovery of the Pear Thrips *Taeniothrips inconsequens* Uzel. a temporary laboratory was established in 1916 at Royal Oak, Dr A. E. Cameron appointed in that year being specially detailed to carry on the investigation with the co-operation of Mr. Treherne. In this work our officers had the assistance of Mr. E. V. White of the Provincial Horticultural Branch. The results of this study which was continued in 1917, were published in Bulletin No 15. In 1916, too, a study of the Codling Moth situation in the province was begun by Mr Treherne with the assistance of Mr M. Ruhmann of the provincial service. In this year, Bulletin No. 12 on the "Cabbage Root Maggot and its Control in Canada" was prepared jointly by the writer and Mr. Treherne. In experiments for destroying insects affecting stored products conducted in 1917, the value of heat was demonstrated in the province for the first time. In that year, in addition, the life-history and control of the Peach Twig Borer,

Anarsia lineatella Zell., were studied by Mr. Treherne, as a result of which, as stated in the report of the Dominion Entomologist for 1917 and 1918, "the spraying of peach and apricot orchards with lime sulphur and arsenate of lead, the pre-blossom spray with lime-sulphur being emphasized, was enforced by the Provincial Department of Agriculture."

In 1918, the federal provincial headquarters were moved from Agassiz to Vernon. Here Mr. Treherne continued Codling Moth and other important fruit insect studies. In this year, a laboratory was established at Victoria, with Mr. W. Downes in charge. From this laboratory investigations relating particularly to insects affecting strawberries and other small fruits were conducted. The Strawberry root-weevil, *Brachyrhinus ovatus* Linn. was specially studied by Mr. Downes and observations on this insect have been continued since. The value of barriers for protecting crops from the weevil has been demonstrated under commercial conditions as explained in Pamphlet No 5, N. S., published in 1922. The Agassiz laboratory was in charge of Mr. A. B. Baird from 1917 to 1920 inclusive. Since then Mr. R. Glendenning has been in charge.

Studies of several lepidopterous insects affecting the apple were continued by Mr. Treherne in 1919. In this year the provincial and federal activities were co-ordinated, Mr. Treherne assuming the general direction of the work. Outbreaks of the Roadside Grasshopper, *Camnula pellucida* Scudd., in the Bridesville-Rock Creek area and in the Chilcoten district; the Lesser Migratory Grasshopper, *Melanoplus atlanis* Riley, at Celesta; and the Red-legged Grasshopper, *Melanoplus femur-rubrum* DeG. in the Fraser Valley, were investigated. In 1920, special studies were undertaken in the Chilcotin district by Mr. E. R. Buckell of the provincial service, under the direction of Mr. Treherne. Studies of the life-history and control of the Imported Onion Maggot, *Hylemyia antiqua* Mg., which had been in progress for several years were continued in the Okanagan Valley in 1919, 1920 and 1921 by our officers in association with Mr. M. Ruhmann of the provincial service, and in the latter two years important demonstrations further emphasized the value of the corrosive sublimate remedy for the Cabbage Maggot, *Hylemyia brassicae* Bouché. In 1920, Mr. Treherne continued studies of insects affecting the apple and biological notes were made on *Mineola tricolorella* Grt.,*Rachela bruceata* Hulst, *Epicallima dimidiella* Wlshm., *Peronea maximana*, Busck, and *Cacoecia rosaceana* Harr., etc. Experiments in the superheating of refrigerator cars for the destruction of larvae, such as those of the Codling Moth, were also incepted with the assistance of the Provincial Horticultural Branch.

In 1921, Mr. Treherne was promoted to the position of Chief, Division of Field Crop and Garden Insects, with headquarters at Ottawa. During his absence from Vernon, the work has been carried on largely under his continued direction with Mr. E. P. Venables assisting locally. This latter officer has from 1921 to date conducted further work on the life-history and control of apple insects. The Fruit-tree Leaf-roller, *Cacoecia argyrospila* Walk., caused noticeable injury in the Okanagan Valley in 1922 and studies of the same were at once begun. These have required the major portion of Mr. Venables' time. In 1920, an important infestation of the Satin Moth of Europe, *Stilpnotia salicis* Linn., was discovered by Messrs. Tothill and Baird in the city of New Westminster. Mr. R. Glendenning was instructed to make a detailed study of the insect and this occupied most of his time in 1921, since when he has continued to make observations each year. A full report on this work is being prepared. The insect has now spread to Vancouver Island. Other insects which have been

specially investigated by Mr. Glendenning from the Agassiz laboratory are *Bembecia marginata* Harr., *Phorbia rubivora* Coq., *Epochra canadensis* Loew., *Psylliodes punctulata* Mels., *Epitrix cucumeris* Harr., *Phyllotreta albionica* Lec. and *Eriosoma ulmi* Linn.

At the Victoria laboratory, Mr. Downes has made excellent progress in the study of small fruit insects. During recent years he has also investigated the life-history and control of the Poplar Sawfly, *Trichiocampus viminalis* Fallen; the leaf-roller, *Cacoecia rosana* L.; and two insects affecting holly, namely *Proteopteryx ilicifoliana* Kearf., and *Phytomyza ilicis* Curtis. In addition, too, he has made systematic studies in the Hemiptera. In 1922. Mr. E. R Buckell was appointed to the federal service. In that year a serious out break. of grasshoppers occurred in the range sections of the Nicola Valley and a temporary laboratory was established at Nicola, in charge of Mr. Buckell, with Mr. P. N. Vroom assisting.

In 1913, a study of the biology and control of bark-beetles was incepted in British Columbia. Control operations on an extensive scale were begun during the winter of 1918-1919 in the Coldwater, Spious, and adjacent valleys, in co-operation with the Provincial and Dominion Forestry Branches. This work has been under the immediate direction of Mr. Ralph Hopping appointed to our service in 1919. Surveys previously made by Dr. Swaine had shown that the Mountain Pine beetle, *Dendroctonus monticolae* Hopk., and the Western Pine beetle, *Dendroctonus brevicomis* Lec., had destroyed millions of dollars worth of yellow pine. With the adoption of control measures, yellow pine trees worth more than six millions of dollars were saved from destruction up to 1922. This bark-beetle control work has given definite and most satisfactory results. It is undoubtedly one of the outstanding examples of such control work yet undertaken. Throughout this whole investigation Dr. Swaine has been closely associated with Mr. Hopping. Outbreaks of the Mountain Pine beetle in lodgepole pine and western white pine and of the Douglas Fir beetle, *Dendroctonus pseudosugae* Hopk., have also been studied and control operations established. In 1921, the Branch published Circular No. 15. "The Control of Bark-beetle outbreaks in British Columbia," by Mr. Hopping. In this year a rather remarkable outbreak of the tussock moth, *Hemerocampa pseudotsugata* McD., occurred in Vernon and adjacent neighborhoods. Injury by this insect in 1917, at Hedley, B. C., and in 1918, at Chase B. C. had previously been recorded, by Mr W. B. Anderson, in *The Agricultural Gazette of Canada*, Vol. 6, 139, under the name of *Hemerocampa vetusta gulosa* Hy. Edit. During the years covered by this review, Dr. Swaine has made several forest insect surveys in a number of sections of British Columbia as a result of which it has been possible to develop control recommendations of considerable value.

A laboratory for mosquito investigations, was established at Mission, B. C., in 1919, with Mr. Eric Hearle, in charge. During this year, a faunal survey of many of the breeding areas in the Fraser Valley was undertaken, and much valuable data assembled. During 1920, the mosquito plague was, next to the actual loss of crop from the flooding of the Fraser river, the most vital economic factor affecting the lower portion of the valley. Nearly all the lumber camps in the affected district were closed down for varying periods, construction of roads was hampered and general farming and horticultural interests seriously handicapped. These investigations were continued in 1920 and 1921. In the latter year with the co-operation of the Air Board,

observation flights were made by Mr. Hearle and photographs taken of the important breeding areas.

Natural control studies, particularly of tent caterpillars, Spruce Budworm and Fall Webworm were begun in British Columbia in 1917, when Dr. Tothill, in charge of such investigations, visited Vancouver Island and other districts. The results of the Fall Webworm studies (1917-1919) are published in Entomological Bulletin No. 19. In 1918, Mr. A. B. Baird, continued these investigations, making his headquarters at the Agassiz laboratory. In the former year (1917) Dr. Tothill liberated colonies of the predaceous mite, *Hemisarcoptes malus* Shimer, collected in eastern Canada, at several places in British Columbia where the Oyster Shell Scale, *Lepidosaphes ulmi* L. was prevalent. Observations made every year since, have indicated that the mite has become well established and is spreading its range. Mr. Baird remained in British Columbia to continue natural control studies until the autumn of 1920 when he returned to the Fredericton laboratory. In 1920, Dr. Tothill visited British Columbia for the purpose of making special studies in connection with the natural control of the Spruce Budworm. The presence of parasites, the value of certain birds, the effect of wind dispersal and other factors were investigated.

The fumigation station at Vancouver erected in 1900 was closed in 1923 and in the same year a modern fumigation and inspection station was erected in the yards of the Canadian National Railway. The new station was built jointly by the Dominion and Provincial Departments of Agriculture.

The work in the Indian orchards in British Columbia which was conducted by the late Mr. Tom Wilson until he met his death in the burning of the Coquihalla, Hotel, at Hope, B. C. in March, 1917, and since by Mr. W. B. Anderson appointed in the spring of 1918, has resulted in much good. The Indians of the various reserves have been informed as to the remedies for the common pests of the orchard, field, and garden ,and demonstrations have been conducted in spraying and other methods of insect control. By working closely with the Indians of the province, both the late Mr. Wilson and Mr. Anderson have made excellent progress. This work, which is under the direction of the Dominion Entomologist, is financed by the federal Department of Indian Affairs.

Provincial

In British Columbia important provincial developments have taken place, particularly in regard to the inspection of plant products entering the province. The province has long had an enviable record in such endeavors and its comparative freedom from many important pests prevalent elsewhere, is undoubtedly due to the wisdom of the late Mr Thomas Cunningham who had charge of such work up to the time of his death in February, 1921. Since this date, the work has been under the direction of Mr W. H. Lyne.

During 1923, the Provincial Department of Agriculture and the Federal Department of Agriculture jointly erected a modern building which will be devoted to the inspection of nursery stock, etc., and the fumigation of plants or other products as may be necessary. In 1914, Mr. J. W. Eastham succeeded Mr W. H. Brittain, as Provincial Entomologist and Plant Pathologist, with Mr M. Ruhmann as assistant in entomology. These officers are still in the employ of the province. In 1918, Mr. E. R. Buckell was appointed as a provincial officer and was detailed at first to Codling Moth eradication work and later to investigations relating to insects affecting range and cereal crops. In 1921, a temporary laboratory was established in the Chilcotin district, with

Mr. Buckell, in charge for the purpose of investigating the species of grasshoppers present on the range lands. Life-history and ecological notes were made on about 40 species of grasshoppers common to range areas.

The Horticultural Branch have published a number of entomological circulars, which with few exceptions were prepared by Mr. Treherne. These are on such subjects as, The Cabbage Root Maggot; The Strawberry Weevil; The Currant Gall Mite: The Onion Thrips; The Woolly Aphid of the Apple; The Imported Cabbage Worm; The Lesser Apple worm; The Oyster-shell scale; The Peach-twig Borer; Locust Control, etc.

During recent years, additional legislation concerning the control of the Codling Moth and timber-infesting insects has been passed by the provincial government.

University of British Columbia

At the University of British Columbia, entomology, has received attention, especially during recent years, lectures dealing with insects having been given by Dr. C. McLean Fraser, Mr. R. C. Treherne and Mr. F. C. Auden

The Entomological Society of British Columbia

Since 1914, this society has continued to publish its valuable Proceedings. In 1916 and later, the society has published separately the systematic and economic papers. These Proceedings have added very materially to our knowledge of the insects of British Columbia.

Report of the Provincial Museum of Natural History

In these annual reports, a number of valuable entomological papers have appeared, particularly by Mr. E. H. Blackmore. A new check list of the lepidoptera of the province is being prepared by Mr. Blackmore. Through his contributions he has added materially to the knowledge of British Columbian insects.

CONCLUSION

I cannot close this paper without paying further tribute to those Canadian entomologists whom death called during the period covered by this review: Fyles Saunders Hewitt, Lyman, Sladen, Heath, Harrington, Reed, Cunningham, Wilson, Woolly-Dod—men, all of whom left their mark in the field in which they were specially engaged. Notices regarding their work have been duly published particularly in *The Canadian Entomologist*. The list is truly a formidable one and the loss to Canada has indeed been great.

MILLARDET

THE CREATOR OF APPLIED PHYTOPATHOLOGY

Prof. Georges Maheux, Provincial Entomologist, Quebec.

Close to the green-houses of the large botanical garden of Bordeaux, in the shade of splendid foliation and beautiful trees, a monument of plain sobriety and beautiful lines is erected. Vine branches loaded with grapes wind up the while stela of white stones; a beautiful nymph, symbolyzing viticulture, offers a bunch of grapes as homage to a bust of considerable size crowning the whole. The visitor charmed, stops before this magnificent sight which results from the perfect harmonization of the art of man with the art of nature. He approaches, in search of precisions to learn from the inscriptions, the name of the hero in whose memory, this imperishable memorial has been erected.

It is the monument raised through the gratefulness of the French and Foreign vine-growers, to the memory of Alexis Millardet and solemnly dedicated on the 15th of July, 1914, in the midst of a considerable concourse of officials, learned men, vine-growers, a few days before the declaration of the Great War. Verily, the erection of this monument was evident proof that the name and works of Millardet are always vivid in the minds of vine-growers of all the universe; his memory is the object of special worship among the proprietors of vine-yards of the southwest of France and of the Department of Grenoble. In fact, Millardet is considered as the saviour of French viticulture and it is as such that his admirers wished to immortalize in stone and bronze his name and features.

Millardet is not unknown among us. Our phytopathologists are of one common accord in giving him the name of the founder of experimental and applied phytopathology; and most of those who occupy themselves with the problems attached to the protection of plants know that his name is closely allied to the anticryptogamic preparation of almost universal use known under the name of Bordeaux Mixture. Indeed, if Millardet was not the exclusive inventor of this marvellous fungicide, he has the merit of having discovered its properties, of having perfected it, of having determined the definite formula and of having propagated its use in all the vineyards. A continued and severe test of forty years has shown beyond all doubt the value of this discovery and the merit of the discoverer.

Born in the Jura, at Monyminey, the 13th of December, 1838, of a distinguished family, Millardet first initiated himself into scientific life at the University of Paris where he studied medicine. His uncle also a physician, was destining him a very alluring estate and clientele. In spite of this alluring reality the young physician, for long drawn towards botany, decided to abandon his profession and to give himself up entirely to his favorite study.

At that time, the teachings and discoveries of a few German botanists were attracting to their chairs the young students of Europe. Millardet also went to Germany to study pure and applied botany with Hofmeister, at Heidelburg, and de Bary at Frielburg. Under the direction of these learned professors, he initiated himself into the art of hybridization which was then assuming considerable development, and plant pathology which was then beginning to give up its secrets.

Returning to France, Millardet obtained from the Sorbonne his degrees of Doctor of Medicine and of Sciences. Still a young man (1869) he became Professor of botany at the Faculty of Science of Strassburg. After the Franco-Prussian war, his former Professor, de Bary, was to succeed him at the professorship of Strassburg and he became Professor of botany at Nancy. It was there that the Academy of Sciences found him in 1876, at the time of the crisis of destruction of the magnificent vineyards of the south of France.

The prosperity of the vine-growing region was dangerously menaced by the Phylloxera, a redoutable insect the multiplication of which was rendering sterile and was ruining the vine yards of France where it elected domicile. As every one knowns, this insect had been imported into France with American vines, and as early as 1862 its presence was discovered. Its ravages at first insignificant increased with the number of its legions, so much that fifteen years later, the officials and savants were moved and resolved to act without delay. The Academy of Sciences took in hand the fight against the invader and delegated to Bordeaux Alexis Millardet as professor of botany with mission to study the ravages and to discover means of combating it. From now on this region will be the field of action of the botanist and phytopathologist; he will occupy for twenty seven years (1872-1899) this post, which he will abandon but three years before his death, in 1902.

Up to that time Millardet had been noted for his researches in pure botany and had thus won a high reputation. On his arrival at Bordeaux his whole time is given to the task of saving the vine, and, by his persevering works, guided by a tested and enlightened science, by an acute sense of observation, saves viticulture from ruin. Without losing time with measures of doubtful efficacy he is searching for a somewhat permanent means of struggle and by this conception of the application he is closely related to Pasteur, the savior of sericulture.

His patient researches permitted him to establish the scale of resistance of the said vines. But this resistance is only partial. Millardet then attempts to guard against this insufficiency by practising hybridization of the types both fecund and resisting. He opened the way to hybridization, showed its technic and created types that have rendered and still render the greatest services to vine-growers.

This first enemy checked, a second raised its head in 1878 and in its turn ravaged the vineyards; it was mildew. From work undertaken by Millardet,

after a deep study of the fatal fungus was born the Bordeaux Mixture of which he became the zealous and incessant propagator.

No one is ignorant that copper is the preservative, the active element of this mixture; it acts as preservative agent by creating on the surface of the exterior organs of the plants a deleterious medium to the development of the organisms of mildew. We cannot, in all justice, attribute to Millardet the merit of this discovery. In 1807, in a note on the rust of cereals, Benedict Prevost, pointed out the unfavorable action of sulphate of copper on the germs of rust, and recommended very weak solutions, namely 1 part of sulphate of copper to 400,000 parts of water. While very remarkable for the time, the note of Benedict Prevost had no sequence.

The appearance of mildew of the vine, well known in the United States since 1824, was to again give it value. Planchon, to whom a monument is erected at Montpellier, in the valley of the Garonne, first discovered the disease.

Several years elapsed before the anticryptogamic specific was adapted and propagated. It was during this period of groping that Millardet, aided by eminent collaborators like U. Gayon, in the laboratory, and M. Bouisset in the vineyards fixed the proportion of the various ingredients entering into the composition of the cupric mixture, now called Bordeaux mixture, from the place of its origin. The wine-growers commenced to employ this preservative in 1885 and Millardet did not spare his efforts to facilitate the rapid extension of the treatment against mildew.

It may be easily imagined that the formula now known only became such after numerous alterations. The first formulas proposed contained a considerable quantity of sulphate of copper. Millardet himself advised 15% of lime and 8% of copper; others even went up to 12% of salts of copper. Thick mixtures were the result (which well merited the name of mixture), difficult to spread. The actual formulas for ordinary treatment do not exceed 2% of sulphate of copper.

Millardet has also explained the action of Bordeaux mixture on mildew of the vine, by suggesting that the cupric solution acts on the spores of certain cryptogamia that it comes into contract with by preventing their germination. This theory applies as well to several other diseases, as may be judged by the popularity Bordeaux mixture has had for nearly forty years. There are hardly any horticultural products for which the use of this fungicide is not recommended as a preservative from numerous diseases. Of course the action of the preparation is not the same towards all of these parasites; but the unanimity of the phytopathologists in its favor is an evident proof of its intrinsic merits.

In Canada, professor Craig was one of the first, if not the first horticulturist to make use of Bordeaux mixture and to recommend its use, about 1895. It has made its way since then and is still largely in use throughout the whole country, principally for potatoes and other vegetables.

Among the publications of Alexis Millardet are to be specially remarked: "Le Prothalle male des cryptogames vasculaires" (1869) and "La Question des Vignes Américaines au point de vue théorique et pratique" (1777); "Résultats généraux sur l'hybridation des vignes" (1894), etc.

The French wine-growers wished to show their gratitude to the memory of the Bordelais botanist for the multiple services he rendered to the French and foreign wine. The work of the sculptor Gaston Leroux, professor at l'Ecole des Beaux-Arts de Bordeaux, interprets by a pleasing allegory this sentiment of gratitude, and recalls the austere features, but stamped with wisdom and benevolence, that characterized the physiognomy of the great departed.

Millardet takes rank with the savants who shed lustre on the rich and sunny south part of France and like them he has now a monument worthy of his name and of his work. The honor was worthy of the workman. Perhaps the Europeans have a better remembrance than we have. Canadian agriculture has also its departed benefactors whose names should be engraved in bronze or marble.

ENTOMOLOGICAL TEACHING IN ITS RELATION TO FARM PROBLEMS

By Dr W. H. Brittain, Provincial Entomologist, Truro, N. S.

The speaker feels that no apologies are necessary for bringing up the question of entomological training for the farm boy, for it is a question that affects all those who may be engaged not only in teaching and extension work, but in experimental work as well.

Those charged with the administration of our agricultural colleges during the past few years have been much concerned by the constantly falling attendance. Where we used to have classes of fifty to sixty, we now have six and seven. The agricultural colleges, as a consequence, have come in for rather severe cristicism and many have gone so far as to accuse them of failure. The fact that a plant designed and staffed to accommodate several hundred students, handles instead a few score, gives much color to such criticism.

Of course it is easy to blame the condition on the prevailing depression in the agricultural industry and this is, without doubt, a potent factor. Another and important reason is the lack of openings for agricultural college graduates as compared with conditions several years ago. When opportunities foremployment in connection with the colleges themselves and in the constantly growing departments of agriculture, etc. were plentiful, there was a real incentive for students to attend the colleges, for while a certain number of students look upon the college as a place to receive an education and to train themselves for more effective work upon the farm, a great number have, in the past, looked upon the course as a stepping stone to a position in technical agriculture. Still

another reason to which many assign a large portion of the blame for the low attendance at our colleges,is the higher academic standard now required for entrance to the degree course. There is no time to discuss this subject at length here, especially as the speaker has already written at some length on this subject in an article which will shortly appear, but it is clear that this is but a minor factor, when we consider that even courses designed especially for farm boys and not leading to a degree for which no entrance acquirements are demanded have suffered in equal proportion.

Whatever the reason for this condition may be it has opened our eyes to this important fact, viz., that heretofore our attention has been focussed on those students who are preparing themselves for a degree to the detriment of the great majority who have no opportunity to take such work and who are in need of our practical assistance. The question is now being asked in many quarters. "Why should our province support an expensive institution to train men to leave our farms and, in most cases, our province and often even the Dominion?" The thought is expressed that, while something may be said for reciprocity in brains, we are now suffering from free trade in one direction only. However we may regard this question we must admit that for every students who takes advantage of our courses there are many who do not and cannot do so and most of us will also admit that even the instruction we have been giving in the past, however excellent it may be for the student proceding to a degree, is capable of considerable improvement from the standpoint of the future farmer. It seems to the speaker that, for this class of students, it is in the highest degree important that we encourage him to study his own business in a way that he has never done before and that we actively assist him in solving the problems that he has to meet in his every day life. If we are at all interested in our work we must make some effort to meet the present crisis and, if we know our business, we must adapt our teaching practices to meet the changing conditions of the day.

I would not be so presumptous as to venture a solution at the perplexing problem of how and what to teach so that the student can and will use it, but I want to indicate without too many details how the Nova Scotia Agricultural College is attempting to deal with the situation. While it must not be supposed for one moment that the same methods will apply to other and different conditions, it is hoped that the discussion of the problems involved will be provocative of thought and that some constructive ideas may be expressed that will be of value to all concerned.

Before taking up the specific question of entomological teaching, it will be necessary for me to outline in a broad way the kind of course that we plan to offer for that class of students who intend to make a life work of farming. For several years we have been offering a two year course of the same length as the regular or degree course and with some success, but we have now had enough experience with it to know that it does not entirely meet the needs of the case.

In the first place it has not satisfied the demand for a less expensive course In addition to this it has been found that, since the science instruction is necessarily of a simpler character than that required by the degree students, the instructors in the purely agricultural subjects have found that they have more time than is absolutely essential for the adequate presentation of their subjects. Without going into the merits and demerits of the alternative plans suggested, I may say that the one finally accepted calls for a course consisting of two three months periods given in two successive years, the term extending from Jan. 1st to April 1st. The course is to be an intensive one and of the most practical character. An earnest effort will be made to adapt the instruction to the student. He will be encouraged to bring forward his own special problems for solution. In his farm bookkeeping, farm management and kindred subjects, the instructors will endeavor to direct his assigned problems so that the student is, as far as possible, studying his own business instead of a purely imaginary one. An essential part of the scheme will be the working out by the student of certain simple problems between his first and second term. The nature of these problems will be determined entirely by the needs and ability of the student and rare good judgment will doubtless be required in assigning these problems. So much for the general statement of the course.

The foregoing explanation enables us to discuss intelligently the character and quantity of entomological work which will be taken up in connection with it. In stating my ideas as to what these should be, it should be understood that I am speaking only for the type of student and for the set of conditions with which I am familiar. The following then are what might be considered the essential features of such a course:

1. **There should be an abundance of good material.**—It is as impossible to teach literature without books as to teach entomology without specimens, and yet an insufficiency of material is a very common fault with elementary courses. The speaker knows of one institution where one battered codling moth served five different classes of students. At the end of that period the thorax and one wing was all that was left, but the specimen was still doing duty. At another institution, where scores of students took the elementary courses every year, there was one very indifferently mounted slide of a horse fly head supposed to show the mouthparts of this insect.

Many instructors who are very particular about the kind of material they give the advanced students, put aside poor or damaged material for their elementary classes. This is exactly the reverse of the proper practice. If it is necessary to use poor material the advanced student is more likely to be able to make something out of it than the beginner, who all too often has serious obstacles to his mastery of the subject placed in his path from this cause. For him the instructor should consider nothing too good.

This naturally entails an immense amount of work on the part of the teacher, but it is work that he must be prepared to do. All of us are acquainted

with the amount of material that can be ruined by a class of students, especially when it consists of pinned specimens. The wastage is often appalling and necessitates the constant renewal of the material. The speaker has found it advisable in all preliminary work such as elementary morphology and taxonomy to use specimens preserved in liquid. This enables the student to handle and study the specimens without the certainty of having them rendered unfit for further use.

2. **The course should be intensive rather than extensive and should not be designed to cover too much ground.**—Any instructor who is enthusiastic over his subject is naturally desirous of giving his student as much as he can in the time at his disposal. This frequently results in the general principles of the subject being smothered in a mass of detail. This is just as true for degree students as for those taking the kind of course that I am describing. Most of you have had the experience of having a colleague try to explain some insect that he has seen attacking some plant. Usually he cannot tell whether it was a bug or a beetle. In spite of the fact that he had had advanced courses in economic entomology and though insects and their activities are forced on his attention every day, he has completely forgotten all he ever learned about the subject. While it is quite natural to forget things we do not use, such cases do not come entirely in this category and the fault, I am convinced, can be attributed in a very large measure to the fact that when they took the work they were given more detail than they could assimilate in the time available.

All will agree that the student should be able to recognize an insect when he sees one and should know enough about mouth parts to distinguish the main types, that he should be familiar with the main orders and the main groups of economic forms within the order, that they should also be reasonably familiar with the immature stages of these orders, that he should be instructed in the preparation and use of such poison sprays or dusts as he is likely to use on his own farm and to be familiar with the injurious stages of the chief farm pests. In such a brief and practical course it would not be necessary for all the students to study exactly the same insects in their laboratory work. For example, a student may come from a fruit district and be interested in fruit alone. Naturally, in his case, emphasis should be placed upon the study of fruit insects, whereas if his chief interest were in live stock the insect pests of farm animals would naturally be given first attention. In our work this idea is being developed, but the extent to which it can be carried out will depend entirely upon the number of students and the assistance available in any particular department.

In dividing the work of the two terms, our practice is to give the general principles of insect structure, classification and control with a few striking examples, leaving the more detailed study of the application of these principles for the second term.

3. **The work should be presented in an interesting, a practical and a non-technical manner.**—Most teachers will agree with this general proposition, but

there will be some differences of opinion as to how this should be achieved. With this type of student it is very little use to give him anything in which he is not interested and which he is not persuaded will be of some advantage to him in his life work.

One of the difficulties that we have all felt is the necessity of having to use dead and preserved material. It is hard to get enthusiastic over a lot of pickled caterpillars or interested in pinned and mounted flies. It is of the greatest advantage to be able to use at least some living material. In the lesson on mouthparts a live aphis from the green house placed on its back in a drop of Canada balsam with legs and antennæ waving in the air and with its beak extending half-way down its abdomen gives a reaction that you can never get from a Cicada taken from a jar of formalin. Aphids, scale insects, etc. can be obtained from greenhouses, some species of leaf-hoppers can be hatched out during the winter months as can many species of moths that hibernate in the egg state. If a greenhouse is available these can be reared and studied there and their work, growth and transformations actually observed. Many animal parasites are, of course, available at this time and can be studied to advantage in the live state.

Then, since the students are eager for practical instruction a lesson in sprays and spraying should be introduced early in the course, preferably following that on mouthparts. The actual materials and the actual machinery can be studied at this time. While actual demonstration of their use is difficult, in fact impossible on a large scale, it is easy to devise a few simple experiments to show that the work is not all "theory" but that it is capable of actual use. If we can get the student to thoroughly appreciate the difference between biting and sucking insects so that they will remember it after they return home, we have done more than even more advanced courses sometimes do. A simple experiment with some greenhouse aphids and some leaf eating caterpillars performed in the greenhouse will demonstrate this in a way that the student will find hard to forget. Then such insects as meal worms, clothes moths, etc. may be studied in the living condition and made the object of simple fumigation experiments. The control of chicken lice or hog lice can also be easily demonstrated in the winter months. Work of this character tends to vitalize our subject and to save it from the "dry rot of academic biology."

Then to achieve our purpose the presentation of the subject should be non-technical. What valid reason can there be to compel the student to master a strange jargon which he cannot and will not use. When a student says he cannot learn any subject because he cannot remember all the long hard names, the instructor should endeavor to remove this difficulty from his path as far as it can be done. Why use up all the student's mental energy merely in memorizing technical terms so that he has none left to learn the subject itself? We might as well make up our minds that there is in the mind of the average student—I mean the average student who takes these courses—an ineradicable prejudice

against technical names. As soon as he hears one of these scientific terms he mmediately tells himself that this is a hard, scientific subject and by scientific he means something difficult and unpractical. He therefore immediately shuts his mind against it—and the capacity of the student mind to resist the introduction of knowledge under these circumstances is practically unlimited. Personnally I do not share the average student's horror of long Latin or Greek names, but when I see that look of patient suffering come over the faces of successive classes of students, when they hear the word metamorphosis, I make up my mind to forego the use of this word entirely as far as our farm students are concerned and to invent a simple one that will convey the same idea. Similar terms such as mandibles, maxillæ, etc., are heard no more in our class room, but Anglo-Saxon words that serve our purpose equally well. Similarly there are no longer any Coleoptera, Hemiptera and Diptera, etc. but beetles, bugs and flies. It is our duty to give our students certain facts and a certain training, if we can do without clothing our ideas in technical language, surely it is better to do so and, if we are willing to take the trouble, it should be quite possible for us to devise suitable terms in cases where they are not ready to hand.

The use of keys such as are commonly found in our text books are also difficult for the boy taking this course to understand. Of course, with time, he can be taught to master them, but we have no time to spend unnecessarily and yet it is of the greatest practical advantage for them to be able to recognize the main orders of insects and not adults alone but their larvæ as well. For this purpose simple recognition charts may be devised which do not require the same amount of practice to use and which can be made to serve the purpose equally well.

All science teachers recognize the great value of drawings, especially in biological subjects. But here again it is easy to overdo the idea in the case of this class of students. There is not the time again and it is hard to convince these students that such time is well spent. While I would not do away with drawings altogether, I would reduce them to a minimum in this course.

Then the question arises in studying economic insects whether it is best to study them according to their natural grouping or according to their host. The speaker has experimented with both methods and feels bound to say that while the latter would seem to be the most natural one for this class of students in actual practice it does not appear to give the best results, in spite of its apparent greater simplicity. When we consider that almost every plant that grows is affected with one or more species of aphis, it will be seen that by studying insects according to the host plant the student has to make a separate mental effort for each species, whereas if he studies them simply as aphids, a single effort will enable him to master the main facts of aphid life history and control. Similarly the control of a leaf-eating caterpillar, whether it affects a turnip or an apple tree, is affected in a similar manner and this is perhaps the reason that

we have obtained better satisfaction in studying insects as cut worms, plant bugs, flea beetles, aphids, biting lice, etc., rather than as pests of various crops or animals. The information can later be summed up, however, in the form of spray calendars or schedules for different crops.

We must also recognize the fact that in the short time available we must not expect to give the student all of the subject. If his interest in and his study of the subject cease with his completion of our course then we have failed as far as that student is concerned. One of the obvious methods of keeping up the student's interest is to place him in touch with the sources from which bulletins relating to the subject may be obtained and to use these in our classes as far as practicable. One of the most important ways in which we can project our teaching on to the farm itself is by assigning simple problems to the students to be worked out between their first and second term of work. By careful questioning it can be ascertained what insect problems the student has to deal with on the home place and it is then the instructor's task to assign a problem that will be along the line of the student's needs and that will be within his ability to carry out. It is of great importance not to assign too hard a problem so that the student becomes discouraged. On the other hand, even a small success has an excellent effect in stimulating interest in the subject. We have already put this plan into practice to a limited extent with gratifying results so far.

In conclusion, whether or not you consider all my conclusions justified, I think it will be generally agreed that we should make an earnest effort to obtain the viewpoint of the student, for his viewpoint is likely to be a very normal one —at least as normal as our own. I realize that it is sometimes hard to do this. For example, it is hard to appreciate the viewpoint of the student who, in reply to the question, in a recent zoology examination, "Explain the importance of annelid structure in animal descent", replied, "The earthworm consists of two parts, (1) bilaterally and (2) symmetrical. It is a onecelled animal belonging to the order Protoplaza and feeds on vegetables, chiefly cabbage and is controlled by spraying with Bordeaux mixture in the pupal stage." One may get tired of hearing that aphids are controlled by hand picking the eggs during the winter months or that the strength of lime sulphur is tested with a barometer. At the same time we must realize our own responsibility in this matter and give as much time to the study of the student, mind as we do the specimens that we give him to study.

THE ORCHARD ENTOMOLOGIST

W. A. Ross, Entomological Laboratory, Vineland Sta., Ont.

As many of the members of this society are probably not familiar with the nature of a field entomologist's work, I do not think I could do anything better than present a paper, which I warn you will be rambling and disjointed, on the orchard entomologist.

His Training

First of all, what training should he have? Several excellent papers bearing on the training of an economic entomologist have been published recently in the Journal of Economic Entomology. In these papers the need of acquiring as broad an education as possible is forcibly pointed out; the importance of some grounding in fundamental sciences such as chemistry, physics, botany, zoology, ecology and meteorology as well as entomology is stressed; in brief all the chief requisites for a thorough training in economic entomology are dwelt on except one viz: some experience, the more the better, in farm or orchard work. I should not presume to add to what has been written by much more capable men regarding the entomologist's academic training, but I do feel contrained to say a word about the orchard practioner's need of having some orchard or farm experience.

The entomologist engaged in fruit insect investigations is concerned not only with insect pests, but also with the relations of the insects to the trees, of the trees to the insects, and of both of these to orchard practices. In combating the insect, in protecting the tree, he has to make use, not only of insecticides, but also of cultural measures. It is, therefore, fundamental that he should have some knowledge of horticulture and that type of knowledge which to a large extent can only be acquired from actual experience. Without this experience, he may lack a proper sense of proportion and may easily fall into the error of considering the control of some pest a problem in itself, and not, as it is in reality, merely a part of the whole problem of orcharding. Without this experience as a background, he may fail to realize that the fruit grower's business is primarily to grow fruit successfully and profitably, and not to kill bugs. Without this experience, he will work under as serious a handicap as that of a medical doctor who has not walked the hospitals—he will have scant knowledge of his patients the trees.

Some Minor Trials and Tribulations

An entomologist cannot afford to be too sensitive. He is very liable, particularly when he is fresh out of college, to meet hard-boiled fruit growers who take a grim delight in showing him how little he actually does know. He is apt to come into contact with men who take the good things he does for granted, but

who never forget his mistakes. He may find himself living among people who are convinced that anyone, who devotes his life to the study of insignificant creatures such as insects, must be queer. I know of one young entomologist, a close friend of mine, a youth with a hyper-sensitive soul, who was stationed in a small town in one of the apple growing districts of Ontario. About a week after he arrived in town, practically everyone knew him, not because he was particularly attractive or genial and sociable, but simply because he was a bug man. If he had been a bank clerk or anything other than an entomologist, he would have received little or no notice except possibly from flappers and their mothers, but because he was a bugman he very shortly had as much notoriety as one of Barnum-Bailey's freaks. In conversing with him everyone in town felt it necessary to introduce the subject of bugs. During hot weather he was usually greeted with—"Well Professor, this is great weather for hatching bugs." On wet days the greeting was changed to—"Well Professor this rain must have destroyed lots of bugs." Brought up in polite society in the Old Country where moths, butterflies, flies, etc., were designated insects, and where the term "bug", never mentioned above a whisper, was applied almost wholly to that disreputable creature *Cimex lecturlarius*, he being a sensitive youth, naturally detested the name bugman. It made his very soul writhe when he was introduced to some interesting damsel as Mr..........., the bug man, and when he noticed her stare of astonishment which was invariably followed by a half suppressed giggle. Some of his friends were even ashamed of his profession and usually introduced him as "Mr........... who works and investigates in orchards you know." The only thing that made life possible for him was to get out among the fruit growers who appreciated the value of entomological work, and who looked on him as being more or less a normal, human being. Every story should have a happy ending, and this one has. In time this young man became hardened and finally reached the stage where he called all insects bugs and even referred to himself as a bugman.

His Workshop and Tools

The entomological laboratory should preferably be located in close proximity to fruit farms, so that the entomologist will be able almost literally to step out of the laboratory into the orchard. Situated in this way, living as it were in a horticultural atmosphere, he is not apt to become so wrapped up in the insect as to forget the orchard.

I shall not attempt to describe or even to list here laboratory equipment, as this sort of information can be readily secured from catalogues of supplies, and as the amount and kind used by the orchard entomologist vary considerably, depending on the nature of the investigations being undertaken, and still more on the funds available for buying supplies. Such equipment as a library or the nucleus of a library, compound and binocular microscopes, equipment for

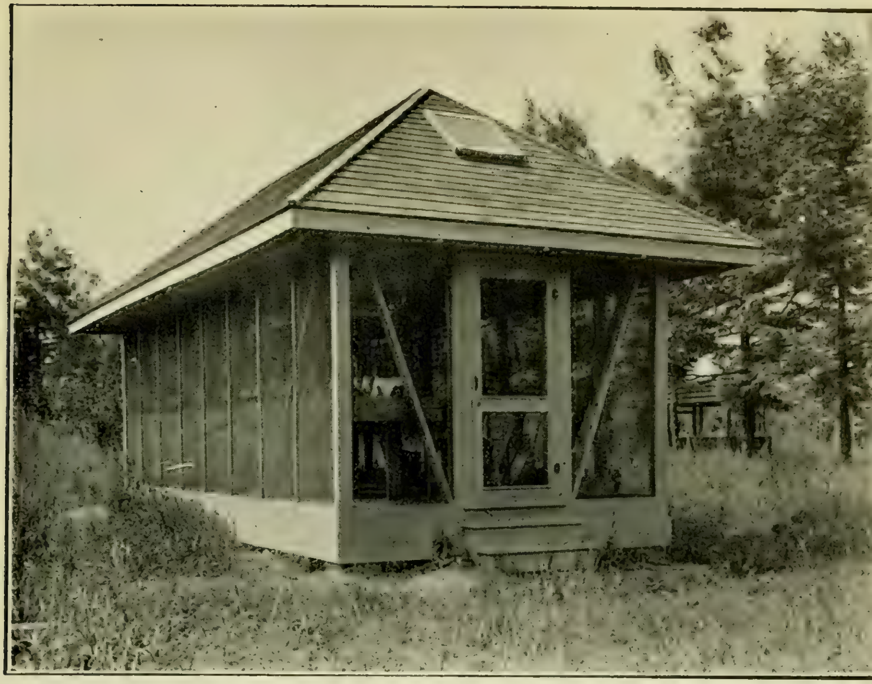


Fig. 1.—Large Insectary, Dominion Entomological Laboratory, Vineland Station, Ont.

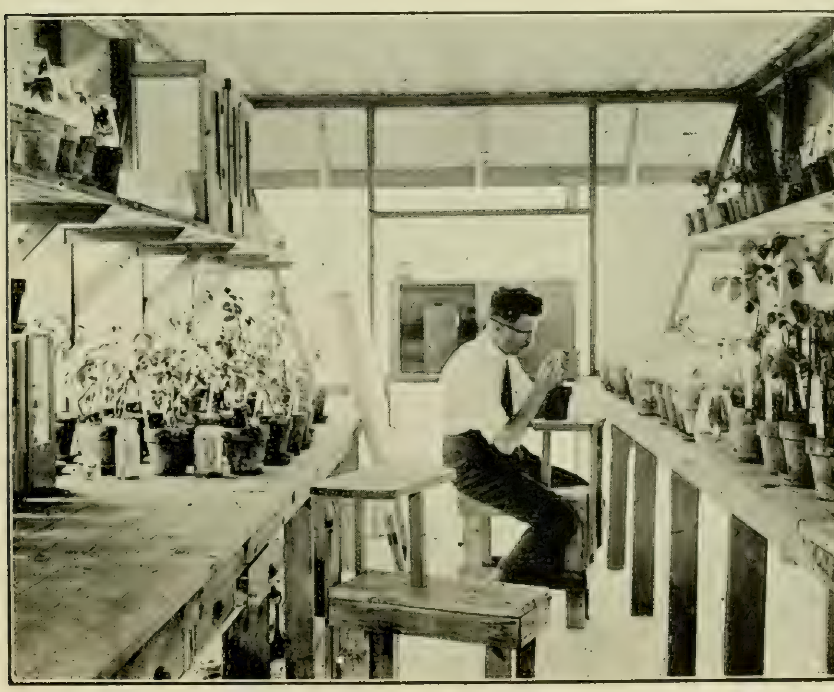


Fig. 2.—Interior of Insectary.

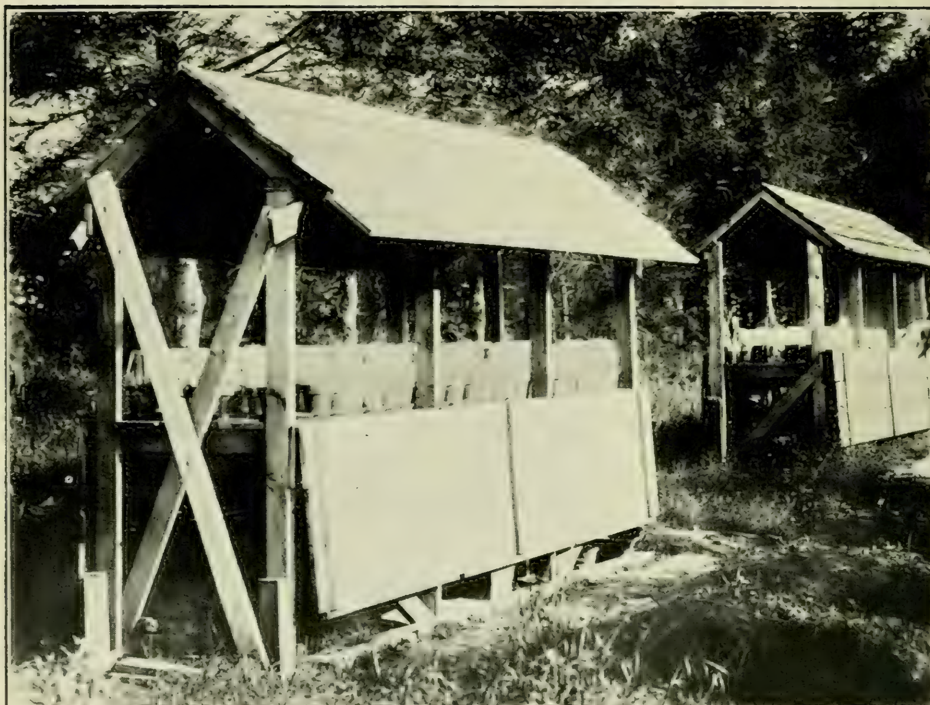


Fig. 3.—Covered Bench Insectaries

collecting and preserving insects, a camera suitable for indoor as well as outdoor work, a cabinet for filing notes, and some sort of spraying apparatus is very necessary. A motor car, preferably the ubiquitous Ford, is practically indispensable, particularly where extension work is being carried on. An insectary and breeding cages, the only equipment I wish to refer to in detail, are also most essential.

At Vineland we have one large and two small insectaries. The large insectary shown in figure 1 is *24'-4"* long, *10'-4"* wide and about *8'-3"* high, and is built on concrete piers. The four walls are covered with rustless wire screening. The interior of the building (figure 2) is fitted on each side with a bench 3 feet wide and 30 inches above the floor and with a shelf 18 inches wide and 30 inches above the bench, both running the full length of the inside; with a tight cupboard built on the back wall in which binocular microscopes, notes books, etc. are kept; and with a water pipe, tap and hose for watering the plants. The only furniture in the building are two home-made stools with small tables built on them on which the material being examined may be placed. Roll curtains made of water-proof, army duck, are fitted on the west and south sides to protect the material in the insectary during stormy weather. These can be readily let down and pulled up.

The two small insectaries shown in Figure 3 are of the covered bench type, with hinged sides which of course are down all the time except during a storm. We have used the covered bench almost exclusively for our work on aphids, and have found it very satisfactory. It has the one disadvantage, however, of not affording the observer protection from the rain on wet days.

Many kinds of cages are being used for rearing and studying insects, but the short time I have at my disposal will only permit me to refer to a few which we have found to be particularly satisfactory. The flower pot cage has, wherever it is practicable, no equal. In our investigations on aphids, pear psylla, potato and grape leaf hoppers and the European red mite, we used this cage almost exclusively. As shown in the illustrations (figures 4 and 5), it consists of a flower pot in which the food plant or plants are grown and of a glass or celluloid cover. For small plants an ordinary lantern globe with a cheesecloth top makes a satisfactory cover. Where the plants are larger, a celluloid cylinder, say 12 inches high and 6 to 7 inches in diameter may be substituted for the globe This cylinder is made from a sheet of clear celluloid. The edges are glued together with acetone, and the top and bottom are reinforced with aluminum tape fastened to the celluloid by means of eyelets; two narrow vents 7 inches by 1¼ inches are cut out opposite each other and are then protected with wire cloth sewn on with thread. The top is covered with cheesecloth and the cylinder is held down in position by means of a wire right-angled hoop with the ends forced into the soil. The celluloid cylinder also answers the purpose of a tree cage (figure 6) for studying the habits of an insect such as the codling moth, and I have no doubt it could be used for several other purposes.

The Riley cage, which needs no description, is eminently useful for rearing leaf-eating larvæ which have to be furnished with fresh food at frequent intervals. The leaves of the food plant can be kept reasonably fresh by placing the twigs or shoots in narrow necked jars containing water and the larvæ can be preserved from drowning by fitting the jars with cheesecloth or cotton batten stoppers.

Ground cages (figure 7) with wire cloth or cheese cloth sides and tops and with sliding doors are valuable for studying the emergence, etc., of insects such as fruit flies and sawflies which spend part of their life history in the soil.

Glass vials in Marx trays (figure 8) may be employed for rearing certain larvæ such as ladybird beetle grubs. At the present time we are using glass vials in our codling moth investigations. The vials with one larva in each are placed in pockets in burlap bands (figure 9) and the bands are tied around the trunk of the tree. The larva in this way are kept under conditions which closely approximate those of codling worms under the bark. It might be of interest to mention here that in replacing a band which has been removed for examination, care is taken to put it back in the same position, so that the insects, say on the south side of the tree, remain on that side of the tree until they emerge as adults.

Cheesecloth cages of different kinds are of value in field or plot work, where it is necessary to cover such plants as raspberries, currants and small grape vines. The cage shown in figure 10 has one end pinned to the sides with safety pins, thus making it possible to lift up the cheesecloth to any height desired in order to see what is going on inside.

Some of His Work

An investigation on a fruit insect pest generally comprises a careful study of its life history and habits under insectary and orchard conditions; a study of the injury to its host or food plants; a study of the effects which meteorological conditions, cultural practices and orchard environment have on its development and prevalence; a study of the parasitic and predaceous insects, birds, fungus and bacterial diseases which may attack it and of the effects which meteorological conditions, orchard environment, etc., have on them, and finally a study of methods of prevention and control.

In the insectary experiments the insects should be reared under conditions as nearly natural as possible. This calls for some ingenuity in devising and trying out various breeding paraphernalia. A simple, uniform system of labelling the cages, etc., should be adopted in order to simplify the recording of observations and in order to eliminate to as great a degree as possible the chance of mistakes being made. What I have in mind can be most easily explained by describing the system we use. In aphid experiments the stem mothers would be labelled as follows: 1_1, 2_1, 10_1, with the date of hatching immediately

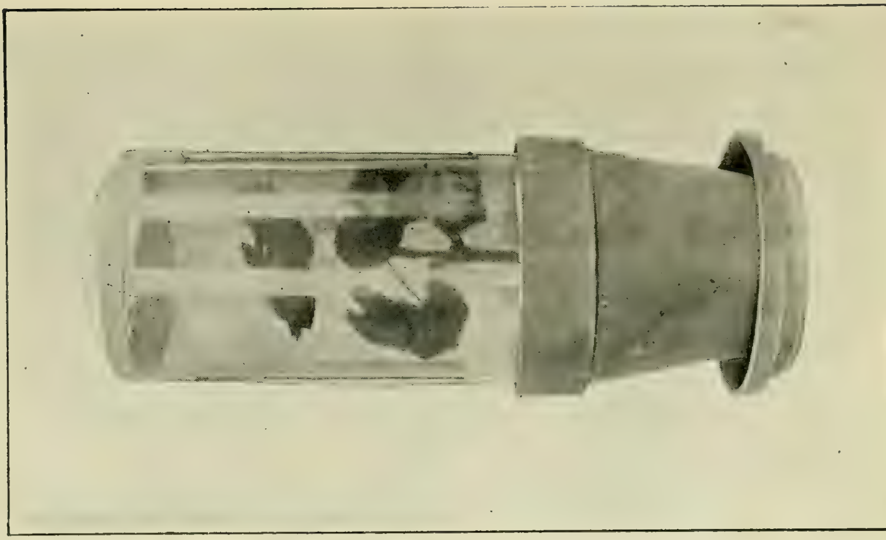


Fig. 5.—Celluloid Cap

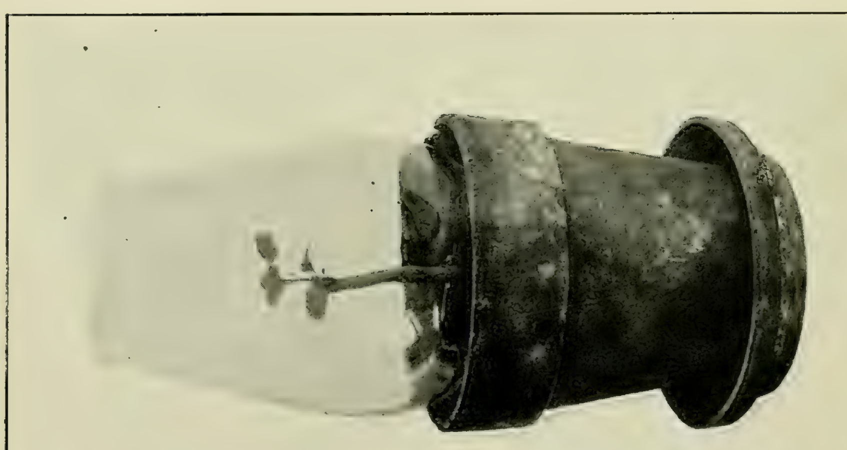


Fig. 4.—Lantern Chimney Cage

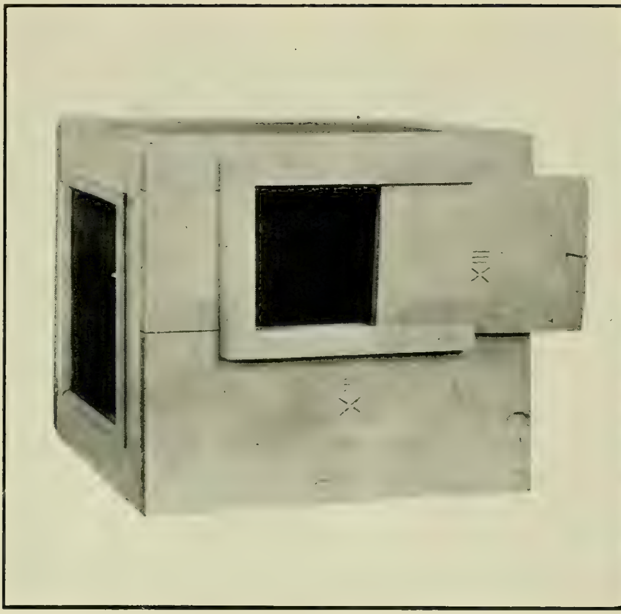


Fig. 7.—Ground Cage.

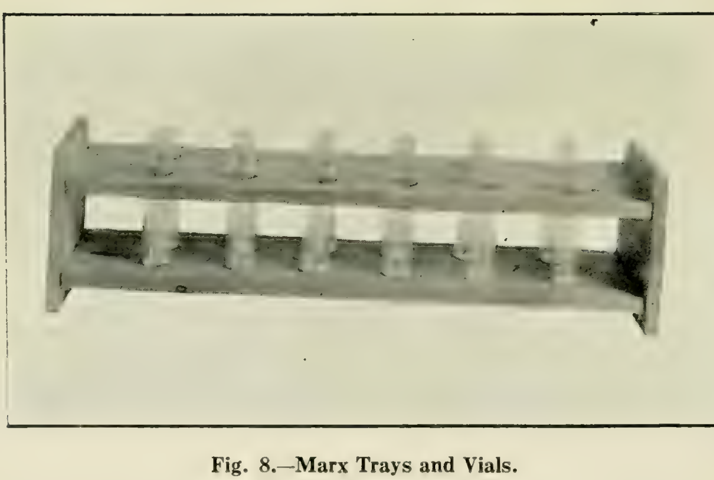


Fig. 8.—Marx Trays and Vials.

Fig. 6.—Celluloid Cages on Apple Trees.

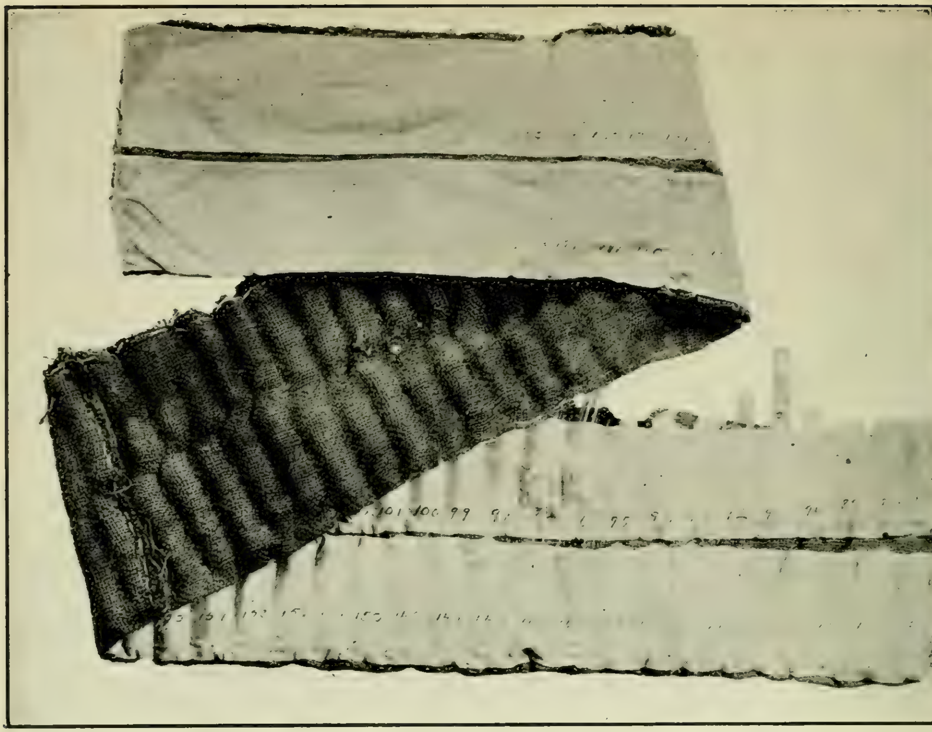


Fig. 9.—Tree band with vials for rearing codling moth larvae.

Fig. 10.—Cotton Covered Cages

beneath the experiment number. The large numeral is the experiment or line number, the small numeral is the generation number. Fourth generation aphids would be labelled: 1_4, 2_4, 10_4, in the first born series, and L 1_4, L 2_4, and L 10_4, in the last born series. 1_4 and L 1_4 would be great granddaughters of 1_1. With an insect like the pear psylla, the method of labelling would be modified in the following way: The overwintering adults would be, e.g. A1, A9, A15; the first generation eggs E 1_1, E 9_1, E 15_1 ; the first generation nymphus N 1_1, N 9_1, N 15_1; the first generation adults A 1_1, and so on. Notes recorded under these simple marks can in many cases be readily put into tabular form.

All important data secured from the insectary experiments should be checked up in the orchard. All critical stages in the insect's development should be, wherever it is possible, correlated with a stage of growth of some common plant, for example, the bursting of peach buds; the "pink" stage of apple blossom buds; the full bloom of European plums; the setting of Concord grapes, and the first blush of early cherries. Phenological records of this nature are highly desirable. They are more valuable than dates which vary too much in different seasons and in different localities. Weather records should be kept and notes should be made on everything having a direct or indirect bearing on the problem under investigation. Full notes should be taken immediately after the observations are made—the memory should never be trusted.

In carrying on control experiments, there are two important principles which should be kept in mind. The first one is that the control of an insect pest is not a problem by itself, but is merely a portion of the complex problem of orcharding. In working out a method or methods of control, the entomologist must take into consideration not only the effect of the treatment on the insect, but also its effect on other insects, on fungus diseases, on the trees, on the foliage and on the condition of the fruit. The second principle is that a remedy which is unduly costly is no remedy, because the orchardist will not adopt it. The question of cost is an extremely important one, and one unfortunately which some investigators are prone to lose sight of. Working in close co-operation with the horticulturist and plant pathologist, the entomologist's ideal should be to keep the cost of pest control down to the absolute minimum, by utilizing to the greatest extent possible horticultural practices such as orchard sanitation, cultivation and pruning; by keeping the number of spray applications down to a minimum, and by modifiing a spray schedule rather than by adding an application to it (wherever this can be done). Right here I feel impelled to plead for closer co-operation among orchard entomologists, plant pathologists and horticulturists. It is true that the entomologist, the plant pathologist and the horticulturist each has his special field of activities, but it is equally true that they have in common a most important field, that of pest control. More than that, they all have exactly the same ultimate object in view, viz: the production of profitable crops of high quality fruit.

In experimenting with insecticides, much time and labour may often be saved, useless materials may often be readily eliminated, very exact data may often be secured by conducting small scale experiments in the laboratory or insectary with definite numbers of eggs, adults or larvæ. The most promising materials can then be tested in blocks or plots, and finally under commercial conditions.

Because of the immensity of the field, and the comparatively small number of laborers in Canada, the orchard entomologist has to do a certain amount of extension as well as research work. Personally, I consider this a blessing and not an evil. I am of the opinion that the investigator who always has in his mind, as it were, a bird's eye view of the whole field of fruit growing is in the best position to secure results which can be converted into orchard practices. This bird's eye view can best be secured and retained by doing some extension work, by keeping in actual contact with fruit growers, and by seeing things from their point of view as well as from that of the entomologist. With this bird's eye view, the investigator is not apt to discover remedies which are impracticable because they are too costly, or because they are otherwise incompatible with commercial fruit growing.

Our extension work at Vineland embraces (1) answering inquiries received through the mail or over the telephone. (2) Visiting to as great an extent as possible, growers with special problems who call on us for assistance. (3) Adressing meetings of fruit growers. (4) Contributing articles to agricultural papers. (5) Sending out mimeographed letters with timely advice in them to men who are sufficiently interested to have their names put on our mailing list. (6) Conducting orchard demonstrations. We make it a rule to work only with bona fide fruit growers, or at least with men who make an honest attempt to grow good fruit, and our days are so fully occupied in doing so that there is little or no time left to devote to the indifferent farmer, who is not and never will be, a fruit grower. We have become sufficiently disillusionized to know that efforts put forth to reclaim neglected, pestridden orchards, which are in the hands of indifferent farmers, are doomed to failure, no matter how much enthusiasm, labour and time are expended.

PLANT DISEASES IN RELATION TO CERTIFICATION OF SEEDS

H. T. Gussow, F. L. S. Dom. Botanist

It is always of interest to review progress in science and the value of pure science applied to the many and varied problems engaging the attention of mankind. In agriculture and related industries we are especially interested; and all of us who have given thought to such a point must have realized how

difficult it is to express in dollars and cents the value of scientific research contributions to the national wealth of Canada. Indeed, it may be somewhat strange to be asked such a question, but nowadays, when everything has been more or less subject to inquiry by efficiency experts, such questions have cropped up again and again. I have always felt in this regard that scientific research cannot be assessed justly as to its value to a country's development, principally because development of natural and established industries is so largely a question of political economy. We may thus—as scientists—be able to solve a number of questions relating to increase of production from every point of view: but increase of production, with all its scientific foundation, does not solve the question of marketing what we have thus increased. In consequence you will agree that whatever we may calculate to be the dollar and cent value of scientific work relating to crop production, it is by no means the only aspect of progress and prosperity of agriculture.

Where, however, our duties commence is to aid in the production of a type or quality of commodity that will give the best and safest returns to the producer or consumer. Thus I wish to introduce the remarks which I wish to make to-day. In general they are applicable to every phase of agriculture, forestry and horticulture—animal as well as plant life.

A good many years ago agricultural seeds were sold in the markets of the world without any restriction whatsoever. It was not until the fundamental work of Stebler and Noble that attention was called to the fact that some of the seeds sold for seed purposes did not germinate. Samples of agricultural seed of very low percentage of germination were quite frequent in those early days, and attempts may even to-day be made to occasionally dispose of seeds of low germination. Gradually the sale of agricultural seeds and seeds generally, was made subject to germination tests, until in due time experience has shown that standard of germination which would make a seed a good and useful quality, and this standard eventually became compulsory by law.

These standards are now pretty nearly uniform in all progressive agricultural countries; but the results of such scientific observation or the application of such observation, rather, to practical problems, it would seem difficult to express in money values. Yet, the farmers of the world owe a great debt of gratitude to the painstaking scientific worker.

The next step in improving the quality of agricultural seeds was the determination of their purity. I do not need to refer here to the importance of this phase, knowing that you are all quite familiar with the merits of such aims. Agriculture has been immensely aided by the use of seeds of high germination and high purity, which includes foremost of all freedom from noxious weed seeds according to definite standards.

In Canada, we know that excellent work in this regard for the benefit of all users of seed, is being done in the Seed Commissioner's laboratories. I under-

stand that seeds of low germination and with impurities in excess of Canadian standards are not even permitted entry into the country.

Unfortunately, this type of work started nearly everywhere far too late. Witness the presence to-day in Canada of many noxious weeds of foreign origin, which cost the farmers thousands of dollars every year in attempts to eradicate.

Aside from the principal factors that a seed must be living and should be pure, progress in agricultural knowledge has revealed further desirable and essential features that constitute seed of superior value to the farmers. A seed must be true to type, true to name, of one variety, etc. To achieve this end it is necessary to start such inquiries before the seed has matured; the seed analyst cannot possibly do justice to these phenomena from a general examination of the seed. Naturally, I am quite aware that certain of these features may be recognized in the seed, especially of the larger kinds: it is simple enough in corn, peas and beans, more difficult in the case of cereals, but impossible in most of the smaller seeds, especially in those of vegetables of the cabbage type.

In consequence, the agrostologists, cerealists and plant breeders generally, joined forces with the seed analyst in studying and standardizing the requirements in this regard.

Their investigations gradually gave rise to what the Germans call "Saatenanerkennung", that is, the inspection of fields used for the production of seeds, and special recognition or certification of such, according to precise systems of inspections and according to kind of seed.

In this connection questions concerning origin of the seed, soil conditions, climate, position and yield, are receiving foremost attention, and necessarily so, since experience has again proved the best teacher in this regard. In reviewing the standards applied in many countries we note that the following constitute a workable basis:

1. Trueness to name, uniformity, purity of variety, freedom from other varieties, absence of weeds, protection from cross pollination and freedom from diseases.

2. Assurance as regards proper crop rotation and general satisfactory handling of seeds, including cleaning and marketing facilities.

As you know, this type of work is carried on in Canada by the Canadian Seed Growers' Association, according to the general principles referred to above.

There cannot be any doubt that present achievements in the production of a high type of agricultural seeds are the interesting results of evolution of knowledge, based upon practical experience and aided by scientific research.

Addressing an audience interested especially in the protection of plants from insects and disease, you will agree that we must start this protection with the seed that is planted; and while the factors referred to already constitute, each and all, most desirable features, a few words on the question of freedom

from disease of agricultural, of for that matter any kind of seed, may not be out of order.

Seed is produced for two reasons, first for direct consumption as such (peas, beans, corn, grain, etc.), and secondly for seed purposes.

In the case of the first group any standards applying to the quality of seeds for direct use by man will cover all those requirements which are more or less obvious.

The production of seed for seed purposes, however, should be subjected to the most stringent rules possible and practicable under the most advanced methods of cultivation. Ordinary methods will not suffice, even though they may be more practicable, but a grower who really desires to fulfill all the requirements of a superior seed must be prepared to go to considerable trouble and look towards the gain in price that is bound to be his, if successful.

Now, in regard to the point--freedom from disease. We require essentially freedom from all such diseases as are conveyed by the seeds themselves. Our inquiries should therefore be directed as follows. (a) diseases carried by seeds, and (b) diseases not carried by seeds; and the former be grouped into (c) diseases that may be controlled by seed treatment, and (d) diseases that are not controlled or difficult to control by seed treatment.

Hence, depending upon the nature of diseases present, entries should be made on the report forms.

Thus, if a grain field shows smuts of a type easily controlled by seed treatment, it should receive, notwithstanding, a more lenient treatment than cereals affected by smuts difficult to control, viz. the loose smuts of barley and wheat.

The great question of practical value, however, is, "Does our present knowledge enable us, as plant pathologists—and insect specialists—to give the definite type of advice in this regard which can be of value to the seed inspector in assessing this phase of his work? "

The ideal, of course, is as always that seed grown for seed purposes should be free from disease. No person should be exposed to the serious risks resulting from seeds that bear the germ of disease, for one can never foresee the conditions that may cause a comparatively slight original infection to assume the importance of a serious epidemic, which may not only result in the loss of the crop, but may also be the source of permanent soil infections.

We have learned important lessons in this regard from our seed potato inspection service now carried on by our division for some ten years or more. What is true of disease-free seed potatoes is equally true in the case of seeds proper. Yet our experience has shown that to demand absolute freedom from disease would at present not be practicable. In consequence, we have adopted a standard in regard to disease that for the present is as good as can possibly be achieved. No doubt as time goes on and conditions still further improve, we shall still be able to increase the quality of seed potatoes. In certain diseases

we cannot permit even now more than a very low percentage, viz. 2%, of leaf roll and mosaic and 3% of wilt and black leg.

There is, however, one very important point that we should consider,—though a disease may be easy or difficult to control by seed treatment, there is an important group of diseases which can not be recognized in or on the seed itself, at any rate, hardly in a quantitative sense such as would be possible to a more satisfactory extent in the field. No manner of simple analysis of seed would reveal the loose smuts of barley or wheat, the club roots of turnips and a good many more.

Hence, as far as a good many diseases are concerned, we should start in the field.

The first point to decide is which of the diseases affecting plants are really carried by the seed? Is the Cercospora spot of mangolds carried by the seed? The Phoma disease? Is it possible to safely distinguish the discolouration of the germ end of grain due to frost from various bacterial troubles?

It seems to me that the question of disease dissemination by means of seeds is an extremely important matter, to which it would appear that sufficient attention has not been given. I feel that this is largely due to the fact that accurate knowledge is lacking on the method by which seeds become infected and carry the diseases. The purpose of my remarks is principally to call the attention of plant pathologists to this matter and to encourage research along this line. I have in my mind to suggest the preparation of monographic studies; possibly this might be accomplished by post graduate workers, among other problems.

Far too little is known of the pathogenic organisms carried by the seed, and still less of the role of other organisms so persistently found on almost all seeds. I need only refer to the importance of the presence of the nitrogen fixing organisms on the seed of leguminous plants, as well as to the remarkable achievement of securing such good results from what would appear to be a symbiotic relation between fungi and the seeds of orchids. Surely investigations into these phases would seem to be warranted, and remarkably useful infor mation may result from such studies.

There is certainly every need for a study of the pathogens, and there is promise enough from an inquiry into the relationship of bacteria and fungi to the seeds and growth of higher plants.

There is another aspect of this matter to which reference should be made. In the beginning I referred to the information which I have on the question of refusing admission into Canada of seed of low germination and purity. What if the presence of seed borne diseases were made a reason for the rejection of agricultural seeds? I mean agricultural seed in a proper botanical sense. In "seed" potatoes you know that such restrictions are already in existence. Indeed the presence of certain diseases in potatoes debars them from entry into Canada altogether—even from countries where the disease is prevalent, even though the potatoes themselves may be disease free. The recent discoveries of "take

all in wheat", of "Earcockle" etc., are cases in point, and in anticipation of such possibilities we wish to be prepared, in order to be in a position to discuss with some knowledge the risks involved.

A stuty of the diseases conveyed by seeds, the mechanism by which seeds become carriers, reliable information on the questions of rational and effective control of seed borne diseases, together with precise information on their recognition in field or in the package, you will agree is urgently called for.

OAT SMUT CONTROL EXPERIMENTS IN 1923

Dr B. T. Dickson, Macdonald College, Que.

Smut control experiments, conducted in co-operation with the Crop Protection Institute, were again carried out at Macdonald College using Hull-less 709 M. C. oats and **Ustilago levis** (K. and S.) Mag. The plots were 5 x 20 links in size, were replicated four times, and were separated by filler plots of the same size.

Grain was treated on May 25th and seeded on May 26th. On the day of seeding the moisture content of the soil was 9.5% and it continued comparatively dry until June 9th when a wet spell set in giving a period of four days with a soil moisture content of 25%. From that time on the season was normal.

The grain was heavily inoculated giving 70% of smut in untreated plots so that a reduction to less than 2% of smut by head count was quite satisfactory.

Several interesting observations were made which, while wellknown, are still worth recording. Concerning stooling, for example, the inoculated by uncontrolled plants stooled much more than treated as is shown in the following table.

STOOLING.—ACTUAL COUNT OF NUMBER OF CULMS.

Treatment	Plot A.	Plot B.	Plot C.	Plot D.	Total
Formalin Sprinkle	923	872	1210	1123	4128
$CuSO_4$ dip	732	850	1053	1027	3662
No treatment	1521	1695	1709	1703	6628
$CuCO_3$ dust	1031	806	1215	780	3832
No treatment	2262	1623	1720	1812	7417
$CuSO_4$ lime dust	1330	1009	907	1158	4404

GERMINATION WAS SOMEWHAT REDUCED BY THE TREATMENTS EXCEPT IN THE CASE OF CuS04 LIME DUST IN THE FIELD.

Treatment.	Lab. Germination	Field Germination	Yield in b.p.a.
Formalin Sprinkle......................	77	65	33.54 $\pm$ 2.38
$CuSO_4$ Dip...........................	83	66	31.60 $\pm$ 1.74
No treatment...........................	93	78	12.48 $\pm$ 0.64
$CuCO_3$ dust..........................	93	75	36.62 $\pm$ 3.53
No treatment...........................	93	80	12.15 $\pm$ 0.64
$CuSO_4$ – lime dust...................	80	83	38.57 $\pm$ 3.28

Times of heading and ripening varied with the treatments. The $CuCO_3$ and $CuSO_4$ lime dust plots headed on July 23rd while all the others headed on July 25th. The untreated plots ripened on August 23rd, the $CuCO_3$ and $CuSO_4$—lime dust plots on August 24th and the others on August 25th.

The percentage of smut by head count varied in the middle rows of the plots from the average except in the case of $CuCO_3$ dust, as shown in the next table.

SMUT COUNT BY HEADS.

Treatment	Av. % in all Rows.	Av. % in Middle Rows.
Formalin Sprinkle........................	1.8	0.9
$CuSO_4$ Dip.............................	0.38	0.16
No treatment.............................	72.8	74.0
$CuCO_3$ Dust............................	1.5	1.5
No treatment	70	74.0
$CuSO_4$ –lime dust......................	1.45	2.6

THE GENERAL RESULTS GIVEN IN THE FOLLOWING TABLE.

Treatment	Germination in lab.	Total Culm count	% Smut by total head count	Yield B.P.A.	Probable error.
Formalin Sprinkle...........	77	4128	1.8	33.54	$\pm$ 2.38
$CuSO_4$ Dip.................	83	3662	0.38	31.60	$\pm$ 1.74
No treatment...............	93	6628	72.8	12.48	$\pm$ 0.64
$CuCO_3$ Dust................	93	3832	1.5	36.62	$\pm$ 3.53
No treatment...............	93	7417	70.0	12.15	$\pm$ 0.64
$CuSO_4$ Lime Dust...........	80	4404	1.45	38.57	$\pm$ 3.28

The writer wishes to acknowledge the following material help: land, seed and labour provided by Prof. Summerby, treatments by J. G. Coulson, M.A. and counts by J. G. Coulson, M.A. and T. C. Vaterpool, B.S.A.

The experiments are to be continued during 1924 with additional treatments by Uspulun, wet and dry, Semesan, wet and dry, DuPont dust No. 13, Deloro Nickel hydrates, Deloro Nickel carbonate, Nickel carbonate Harshaw, Fuller and Goodwin, and Sodium fluoride.

STUDIES CONCERNING INJURY TO SEED OATS AFTER SMUT DISINFECTION.

W. L. Gordon, B. S. A., M. Sc.

INTRODUCTION.

The following investigation was undertaken to determine the factors which induce injury to seed oats after smut disinfection, and if possible to find remedies for the injury. Different treatments, efficient in oat smut control, have been recommended in the past, but little has been definititely observed regarding the action of such treatments on the germination of the seed.

Scope of Investigations.

The present studies were carried on in the Department of Botany, at Macdonald College, McGill University, during the second term of 1922-23, and the second of 1923-24. They were thus of necessity, confined to the laboratory and green-house tests.

The following factors were considered :

1. Effect of varying strengths of formalin solution.
2. Effect of duration of treatment.
3. Effect of temperature of treatment solution.
4. Effect of carbon dioxide on the germination of treated seed.
5. Effect of presoaking before formalin treatment.
6. Relation of soil moisture to formaldehyde injury with limed and unlimed seed.
7. Effect of dry storage after treatment.
9. Comparison of the effects of different smut treatments.

It was planned to study the permeability of seed coats, and the effect of soil temperature on treated seed, but time did not allow the satisfactory undertaking of the work.

Historical Account of Seed Injury.

The injurious effects of fungicides upon the vitality of seeds have been studied by numerous investigators in various countries. Most of the investigations along this line have taken place in recent years. However, observations regarding injury have been made at irregular intervals for a half century. The results of some investigators are given below in chronological sequence.

Isidore, in 1876, found that seeds of wheat dipped in boiling milk of lime for two or three minutes lost the power to germinate; 54 per cent of the seeds germinated after being dipped for three minutes in a solution of 2 per cent copper sulphate, at 60 C., and 63 per cent at 50 C.

In 1891, Arthur observed that, when oats were treated with copper sulphate the plumules emerged earlier than the rootlets. This was due to "the fact that the primary roots were killed before starting and the secondary ones, which took their places, were consequently late in appearing".

Bolley, in 1895, stated that wheat dusted with air-slaked lime after having been sprinkled with a copper sulphate solution, was not reduced in germination to the same extent as seed treated with a copper sulphate solution alone.

In 1899, David ascertained that the degree of injury by formaldehyde varied with the different cereals, and was in direct proportion to the strength of solution and the duration of treatment. The seed injury was manifest in a retarded and abnormal germination in which no roots were produced. The injurious effects of the formaldehyde were reduced by soaking for fifteen minutes in a weak solution of ammonia.

Cranefield, in 1901, and again in 1902, observed that a formalin solution as weak as 2½ parts to 1000 injured the germination of oats. The injury varied from 6.4 per cent to 17.4 per cent. When stronger solutions were used the percentage of injury increased in direct proportion to the strength of the solution. An increase in the length of the time did not proportionately increase the injury when the standard formula was used (2½ parts to 1000).

In 1902, Mezentzov working in Russia, determined the effects of planting untreated and treated seed in a dry and moist soil. The treatments used were copper sulphate with and without subsequent lime-water bath, and hot water. He obtained higher germination percentages in moist soil. both with untreated and treated seed.

Stevens, in 1909, ascertained that the amount of injury to oats treated with formaldehyde depended upon the duration of treatment, strength of solution and quality of seed. Oats dipped in milk of lime after treatment with formaldehyde showed an improvement in percentage of germination.

Stewart and Stevens in Utah, in 1910, found that the injury to wheat, oats, and barley when treated with formaldehyde increased as the concentration of the solution was increased. Oats were more resistant to the influence of formalin than were wheat and barley. They state that of seed is thoroughly dried it may be kept for at least six weeks after treatment.

Gussow, in 1913, stated that chemicals, while very effective in controlling smut, exerts an injurious influence on the grain. Formalin treatment was found to exert a very curious influence upon wheat kept in storage after treatment. Figures regarding this, furnished him by Dr. C.-E. Saunders, Dominion Cerealist, show that wheat originally germinating 75 per cent had lost its life completely when retested one year later. A sample of oats originally germinating 62 per cent and one of barley with 71 per cent, germinated a year after treatment 2 per cent and 3 per cent, respectively.

In 1918, Kiessling in Germany, noted that individual lots of seed varied widely in their reaction to the injurious effects of formaldehyde. An apparent stimulation to germination occurred in some cases. Oats were not found to be injured by storage after treatment.

Braun, in 1920, determined that presoaking cereals in water decreased the injurious effects of formaldehyde and copper sulphate.

Hurd, in 1920, found that if treated wheat is held several days or more before sowing, it is severely injured if allowed to dry without thorough aeration during the storage period. The seed injury on drying was apparently due to a deposit of paraformaldehyde on the seed.

Howitt and Stone, in 1922, reported their results from the use of the dry formaldehyde treatment for oats. In the four years experiments the average percentage of germination of treated and untreated seed was found to be exactly the same, namely 97.5 per cent.

In 1923, Fraser and Simmonds at the University of Saskatchewan, reported that no seed injury resulted from the use of copper carbonate.

Tisdale et al., in 1924, came to the conclusion that with either a water or lime-water dip, after formaldehyde treatment, a greater part of the injury was prevented. With barley, and oats, the organic mercury compounds were found to improve the germination and yields, as well as the control of the smut.

Methods of Experimentation.

In the studies carried on to determine the injury to seed oats after smut disinfection the following varieties of oats were used, having the stated percentages of hull.

Hulled oats.	**Percentage Hull.**
Banner, 4407 M.C.	30.18
O. A. C. 72	27.04
Alaska (G)	22.00

Hull-less oats.

Liberty, Ottawa 480.

For the purpose of comparison with the oats, as to amount and type of injury produced, the Marquis variety was used in many of the experiments.

The disinfectants used in the different studies were formalin (40 per cent solution), copper carbonate and Uspulun. These were obtained from the Department of Botany, Macdonald College, Qué.

The germination tests were carried out, either in the Botanical laboratory at room temperature, (17-20 C.), or in the greenhouse. The seed was placed to germinate, on sand, in sand, or in soil.

Seed lots, of 45 grams, approximately 1-10 of a pound, were usually used for treatment as well as for controls. From each seed lot, two, 100 seed samples were used for the germination tests. The percentage of germination was counted at least three times, the last count being made on the tenth day after planting.

Effect of Varying Strengths of Formalin Solutions.

In order to determine the relation between the strength of solution and the amount of injury produced by formalin treatment, the following experiment was undertaken. Seven strengths of solution were used; one pint of formalin to 60 gallons of water (1:60), one pint of formalin to 50 gallons of water (1:50), one pint of formalin to 40 gallons of water (1:40), one pint of formalin to 30 gallons of water (1:30), one pint of formalin to 20 gallons of water (1:20), one

pint of formalin to 10 gallons of water (1:10), one pint of formalin to 2 gallons of water (1:2).

The samples of seed were dipped for ten minutes in the different formalin solutions mentioned. The temperature of the solution was 18 C. In every case, as a control, similar samples of seed were dipped in tap water for the same length of time.

After treatment the seeds were drained for ten minutes and covered for one hour. They were allowed to dry and then placed to germinate on the top of moist sand in flats. The flats were placed in the greenhouse, kept at a temperature of 19–22 C.

When germination commenced, the number of seeds which had germinated were counted each day and recorded. The final count was made on the tenth day after the seeds were placed to germinate.

In the following table, the percentages denote the average of the two samples of seed, of each variety.

TABLE I.

Effect of Varying Strengths of Formalin Solution.

Solution Strenght	VARIETIES				
	Banner, 4407 M.C.	O.A.C. 72	Alaska (G)	Liberty, Ottawa 480	Marquis wheat
1:60	98.5	99	98.5	83	91
1:50	98	100	98	77.5	90.5
1:40	100	99	99	62	90
1:30	98	100	98	61.5	83
1:20	98	99	100	55	65
1:10	95.5	97	96	38.5	40
1:2	45	53	43	0	0
Control	100	99	100	87.5	91

It will be noted from Table 1. that all the formalin solutions, except the solution strength of 1:2 had very little effect upon the germination of the hulled varieties of oats. Both the Liberty oats and the Marquis wheat were reduced in percentage of germination as the strength of the solution was increased. It will be observed, however, that the Liberty oats were much more sensitive to the action of the formalin than the wheat.

Repetition of these tests gave practically identical results. Therefore, it seems evident that, for the control of smut in the Liberty oats, the formalin treatment is not a satisfactory one, owing to the injury incurred by the seed. It appears, however, that the hulled varieties can be subjected to the formalin treatment, necessary for smut disinfection, without injury occurring to the germination of the seed.

Effect of Duration of Treatment.

To test the effect of duration of treatment, two, 100 seed samples of the different varieties of seeds were counted out and dipped in a solution of formalin, 1 pint to 40 gallons (1:40), for varying lengths of time. The control samples of seed were dipped in tap water, instead of the formalin solution, for the different lengths of time.

After treatment the seed was drained for ten minutes, covered for one hour, and then allowed to dry before being placed to germinate. The seed was germinated on the top of moist sand, in flats kept in the greenhouse, at a temperature of 19–22.5 C.

In the following table the percentages denote the average of two samples of seed of each variety.

TABLE II.

Effect of Duration of Treatment.

Duration of Treatment	VARIETIES				
	Banner 4407 M.C.	O.A.C. 72	Alaska (G)	Liberty Ottawa 480	Marquis wheat
10 minutes :					
Treated	99	99	100	83	97
Control	99	98.5	99	92.5	96.5
30 minutes :					
Treated	100	99	98	78.5	96
Control	98	99	98	91	97
1 hour :					
Treated	98.5	98	94	68.5	94.5
Control	100	99	95	95	95
2 hours :					
Treated	100	100	98.5	65.5	91
Control	100	97.5	99	97	95.5
4 hours :					
Treated	97.5	98	95	60.5	89
Control	99	100	100	97	94
16 hours :					
Treated	85	92.5	82	6	
Control	96.5	97.5	97.5	87	
32 hours :					
Treated	84	91.5	77.5	4.5	
Control	98.5	98.5	97	92.5	

It will be readily observed from Table II that the ordinary duration of treatment is not a factor of primary importance in the germination of the hulled varieties, when the seed is dipped in a solution of formalin of 1 pint to 40 gallons (1:40). There was, however, a decided injury when the seed was treated for

an unusually long period. This injury showed itself both in a retardation and reduction in germination.

The Alaska variety was injured to a greater extent than the other two hulled varieties. The greater injury, in this variety, appeared to be due to the fact that, when the seed was soaked for any length of time in a solution, the hull became loose around the kernel allowing the formalin solution to penetrate to the embryo more easily.

It was noted that where germination was adversely affected, it was nearly always due to the failure of the radicle to emerge, although in some cases the plumule was also distorted. There were also cases where neither the plumule nor the radicle appeared.

The Liberty oats were injured in proportion to the duration of treatment. Extending the duration resulted in extreme injury being produced. The type of injury in this variety was the same as that already mentioned.

It can be concluded from the results, obtained in the above experiment, that hulled oats may be subjected to the formalin treatment, for a considerably longer duration of time than that required for smut disinfection, without any appreciable injury to the seed. The Liberty oats are very sensitive to the action of the formalin solution, and any unnecessary amount of time taken in treatment may result in extreme injury to the seed.

Hurd (1921) of the United States Department of Agriculture, found that the temperature of the solution was a factor in the resistance of wheat to long immersions in a saturated copper sulphate solution, the germination being poorer as the temperature increased. It was thought that probably a similar relation might exist with oats, even when the recommended strength of formalin solution for smut control was used.

Samples of seed, taken as in previous experiments, were dipped for ten minutes in a formalin solution of 1 pint to 40 gallons (1:40), at the different stated temperatures. Control samples of seed were dipped, for the same length of time in tap water at the same temperatures. The solutions were maintained at the required temperatures by means of bunsen burners. The beakers containing the solutions were placed in hot water baths at the respective constant temperatures. After treatment the seeds were drained, covered for an hour, allowed to dry and placed to germinate as previously.

In the following table the percentages given are the average of two samples of seed of each variety. The germination count was made at the end of ten days.

TABLE III.

Effect of Temperature of Treatment Solution.

Varieties	Temperatures				
	10 C.	18 C.	30 C.	35 C.	40 C.
Banner, 4407 M. C.:					
Treated	99	98.5	98	98	98.5
Control	99	98	99	97.5	98
O. A. C. 72.:					
Treated	98.5	99	97	96.5	98
Control	99	100	97	97	99
Alaska:					
Treated	97	99	96.5	98	94.5
Control	97	98	97	99	97
Liberty, Ottawa 480:					
Treated	89	81.5	78	76	61
Control	98.5	93	98	94	94
Marquis wheat:					
Treated	96	96	89	84	82
Control	98	96.5	96	92.5	90

There was no appreciable reduction in germination of any of the hulled varieties, either with a low or high temperature of solution. With the Liberty oats there was a gradual decrease in the percentage of germination as the temperature of the formalin solution was increased.

Effect of Carbon Dioxide on Germination of Treated Seed.

The fact that seed germinated in an atmosphere of carbon dioxide, are retarded or reduced in their germination has long been known. The present experiment was carried out to determine whether formalin seed were more injured than untreated seed when germinated in an atmosphere of 50 per cent carbon dioxide and 50 per cent air.

Samples of Banner, a hulled variety, and Liberty, a hull-less variety were taken and treated for ten minutes in a solution of formalin of 1 pint to 40 gallons (1:40). The control samples were dipped in tap water for the same length of time.

The treated and the untreated samples of seed were placed to germinate on pieces of wet blotting paper, in the bottom of petri plates. The petri plates were floated in the sink partially filled with water. Over these was inverted a graduated bell-jar. The air inside the jar was adjusted to 3 litres by means of water displacement. Carbon dioxide was then generated and added to the bell-jar by means of a rubber tube placed under the bell-jar beneath the water.

The carbon dioxide was then allowed to enter into the jar until the water was driven down to the 6 litre mark. This atmosphere, of half carbon dioxide

and half air, was retained by adding sufficient carbon dioxide each day, to keep the water at the 6 litre mark. It was found that the water absorbed considerable of the gas, requiring an addition to be frequently made.

As a further control another set of seed was placed under a bell-jar, in a similar manner, in an atmosphere of air alone. Observations regarding the rate and type of germination were made each day on the different lots of seed.

In the following table the germination percentages of the different lots of seed are given.

TABLE IV.

Effect of Carbon Dioxide on the Germination of Treated Seed.

Atmosphere	VARIETIES	
	Banner, 4407 M.C.	Liberty, Ottawa 480
Carbon dioxide and air :		
Treated	93	63
Control	94	83
Air :		
Treated	96	81
Control	98	96

As was be expected, there was a retardation in all the seeds germinated in the atmosphere of carbon dioxide compared with those germinated in the atmosphere of air. No retardation was evident in the Banner oats treated with the formalin solution, and germinated in the atmosphere containing carbon dioxide, compared with the control in the same atmosphere. There was, however, a noticeable difference in the rate of germination in the Liberty oats. The retardation was followed by a reduction in germination. The above results would suggest that the Liberty oats were more sensitive to the inhibitive action of the carbon dioxide than the Banner.

Effect of Presoaking Before Formalin Treatment.

The previous experiments have shown that the Liberty oats are apt to be extremely injured by the formalin dip method of treatment. In order to find a means of preventing or reducing this injury, presoaking of the seed in water was resorted to before the seed was dipped in the formalin solution. Braun (1920) found that this was a helpful means of reducing and preventing injury to seed wheat due to chemical disinfectants.

Lots of seed, obtained in the usual manner, were soaked in tap water for three hours, drained, and kept in moist chambers for three hours. On removal of the seed from the moist chambers, part of each variety was taken and treated

in formalin solutions of the following strengths, 1 pint to 40 gallons of water, 1 pint to 20 gallons and 1 pint to 2 gallons. The different lots of seed were dipped for ten minutes in each solution, the temperature of the solution being 18 C. After treatment the seed was drained, covered for an hour, and spread out to dry. As a control for the above, similar sets of seed were simply treated in the formalin solutions, without being presoaked.

When dry, two, 100 seed samples were taken from each seed lot treated and planted in soil in flats. The moisture content of the soil at the time of planting was 16.2 per cent. This moisture content was maintained as nearly as possible during the period of germination.

In the following table the percentages of germination, at the end of ten days from the time of planting are given. The figures denote the average of the two samples of seed.

TABLE V.

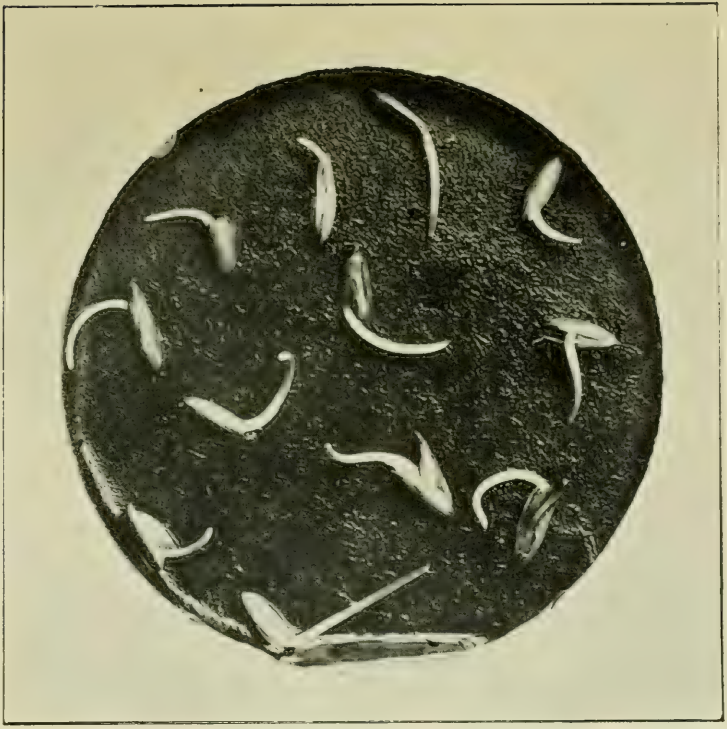
Effect of Presoaking Before Formalin Treatment.

Solution Strength	Varieties				
	Banner, 4407 M.C.	O.A.C. 72	Alaska (G)	Liberty, Ottawa 480	Marquis wheat
1.40 :					
Presoaked and treated	91.5	98.5	92	52	91
Treated only	90	98.5	91.5	20.5	90
1.20 :					
Presoaked and treated	64	68.5	64.5	5	50
Treated only	64	65.5	65	....	38
1.2 :					
Presoaked and treated	....	....	....	....	1.5
Treated only	....	....	....	....	....

The figures in Table V show that the presoaking of the seed as outlined was of no special value, if any, to the hulled varieties of oats, in reducing seed injury. The presoaking was advantageous in reducing the injury to the Liberty oats but unless the seed is planted at once or dried quickly after treatment it is liable to commence germinating.

The chief value of the presoaking before treatment, was the apparent stimulative effect it had on the germination of the seed. The seedlings of presoaked seeds, of all varieties, treated in a formalin solution of 1 pint in 40 gallons, had emerged on the fourth day after planting. None of the other seedlings were noticeable at the time. They were a day later in apperaring above the surface of the soil.

Hulled
oats.



Note
plumules
only.

Fig. 1.—The characteristic type of injury to the hulled varieties produced by formalin treatment. Note the absence of radicles.

Hull-less
oats.

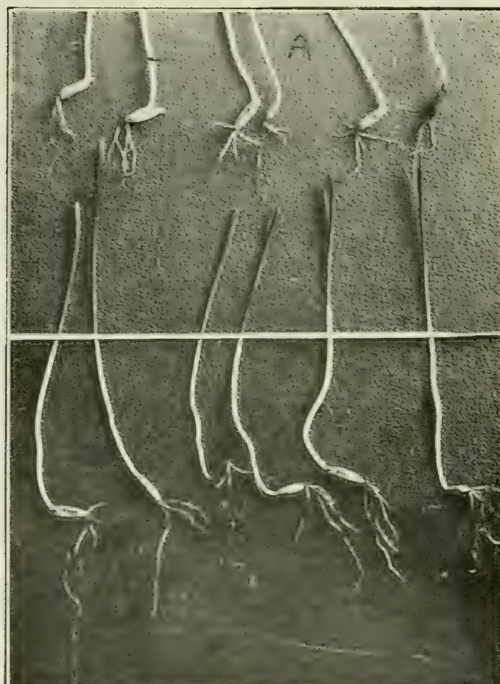
No
growth
of
root.

Fig. 2.—The characteristic type of injury to the Liberty oats produced by formalin treatment.

PLATE II.

Fig. I.

Note root systems.



Formalin only.

Milk of lime dip after formalin.

Fig. II.

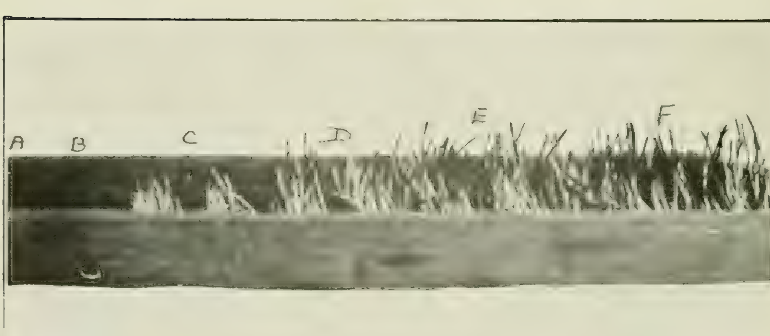


Fig. III.

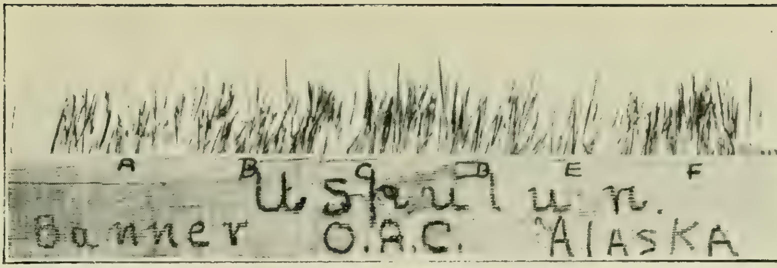


Fig. 1.—Showing the effect of Uspulun on the germination and growth of the hulled varieties of oats. Apparently, there is no stimulative or retarding effecting due to the treatment.—A. Banner, treated.—B. Banner control.—C. O.A.C. treated.—D. O.A.C. control.—E. Alaska, treated.—F. Alaska control.

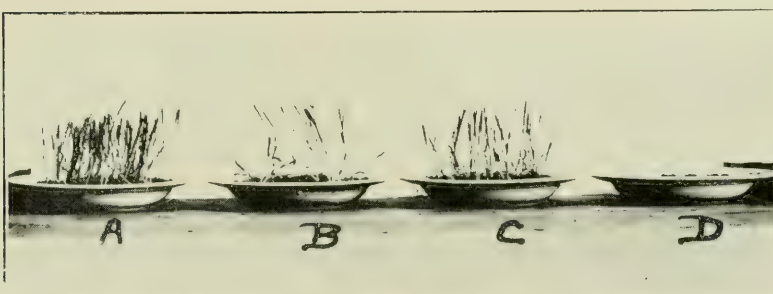


Fig 2.—Comparison of the effects of different smut treatments. The different sets of seeds were planted in soil, as shown.—A. Liberty oats treated with Uspulun.—B. Liberty oats, treated with copper carbonate.—C. Liberty oats, control, untreated.—D. Liberty oats treated by the formalin dip method.

Fig. 3.—Showing the root systems of the sets of seeds in Fig. 2.—A. Liberty oats treated with Uspulun.—B. Liberty oats treated with copper carbonate.—C. Liberty oats, control, untreated.

PLATE IV

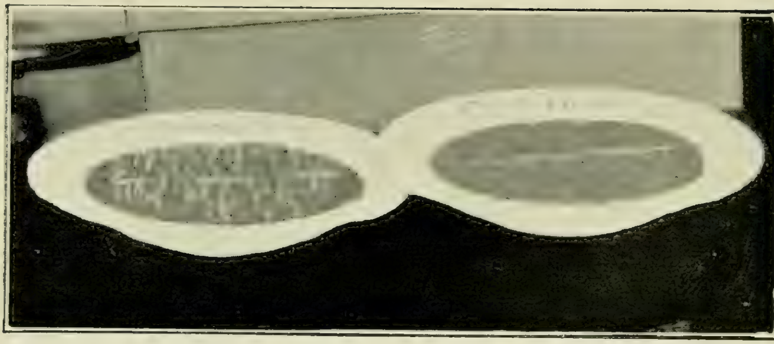


Fig. 1.—Showing the effect of Uspulun on the germination and growth of Liberty oats. The seed was planted in moist sand.—A. Liberty oats treated with Uspulun.—B. Liberty oats, control.—Photographied five days after planting.

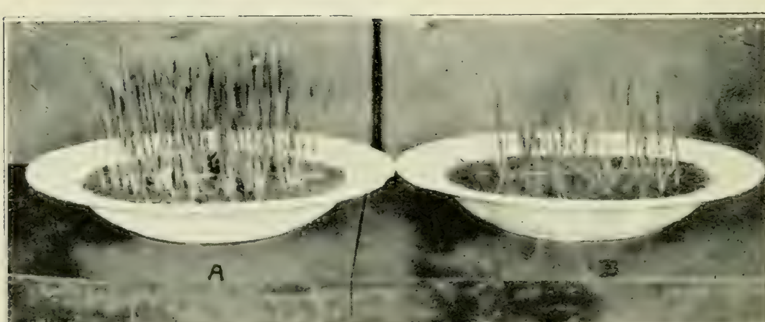


Fig. 2.—A Same as above.—B. Same as above. -Photographied ten days after planting.

RELATION OF SOIL MOISTURE TO FORMALDEHYDE INJURY WITH LIMED AND UNLIMED SEED.

The following experiment was carried out for two purposes. Firstly, to determine the relation of soil moisture to formaldehyde injury, and secondly, to determine the value of a milk of lime dip after the formalin treatment.

The different seed lots were dipped in the formalin solutions for ten minutes. When removed they were drained and covered for an hour. After they were uncovered, part of each seed lot was dipped in a 1 per cent milk of lime solution for ten minutes.

After treatment, samples of seed taken in the usual manner were planted in a dry and wet soil. The dry soil had a moisture content of 8.5 per cent, and the wet soil 19.6 per cent, at the time of planting. After the seed had been in the dry soil for three days, it was made up to the same moisture content as the wet soil. The results are presented in following table:—

TABLE VI

Relation of moisture to formaldehyde injury with limed and unlimed used.

Solution Strength	Soil	Banner 4407, M.C. Unlimed	Banner 4407, M.C. Limed	Alaska (G). Unlimed	Alaska (G). Limed	Liberty Ottawa 480 Unlimed	Liberty Ottawa 480 Limed	Marquis wheat Unlimed	Marquis wheat Limed
1:40	Dry Soil......	90.5	93.5	86.5	93.5	24	39	85.5	92.5
	Wet Soil......	90.5	92	86.5	94	25	37.5	87.5	93.5
1:30	Dry Soil......	95	98.5	94	96	28	71	77	90.5
	Wet Soil....	95	98	94.5	97.5	21.5	67.5	80.5	92.5
1:20	Dry Soil.....	88.5	98.5	80	97.5	8.5	49.5	51.5	90.5
	Wet Soil....	89	98.5	80	97	10.5	41	61.5	82.5
1:10	Dry Soil.....	74	84.5	63	79.5	6.5	44.5	41	60
	Wet Soil....	74.5	85.5	64	79.5	12	45	58	85
1:2	Dry Soil.....	7.5	40.5		47		6.5		19
	Wet Soil....	8	41	2.5	47.5		8	1	23
Control	Dry Soil.....	92	91.5	89.5	89	69	68	89.5	90.5
	Wet Soil....	92	91.5	90	90.5	71.5	71.5	90.5	87.5

Note—Control, unlimed.—seed was dipped in tap water for ten minutes.
Control, limed.—seed was dipped in tap water for twenty minutes.

The most outstanding result of this experiment was the beneficial effect on germination produced by the milk of lime dip after the formalin treatment. In all cases it resulted in an increase to germination over the unlimed seeds, with both the wet and dry soils.

Besides reducing the percentage of injury to germination, the milk of lime dip appeared to hasten germination in many cases. In all cases the limed sets of seed emerged from the soil ahead of the unlimed, and in some cases ahead of the controls.

The beneficial effect of the milk of lime dip was more pronounced as the strength of the formalin solution increased. There appeared to be a greater development of the root system of the limed seed, than of the unlimed seed.

Although there was little difference between the percentages of germination, of the oats planted in the dry and wet soil, it is possible that there would be a greater reduction in the germination of the seed planted in the dry soil if the moisture content had been maintained at 8.5 per cent for a longer time. This is evidenced by results in the field when seeding time is very dry as in May 1923.

EFFECT OF DRY STORAGE AFTER TREATMENT.

It is often found convenient, and sometimes necessary, to store oats for a period before planting. This may be carried out in order to save time in the busy season, or it may be necessary because of weather conditions not being favorable for planting immediately after the seed has been treated. This practice has been considered doubtful, on account of reports of cases of seed injury occurring when seed was stored.

Samples of seed were taken in the usual manner, and dipped in a solution of formalin, 1 pint to 40 gallons, for 10 minutes. After being drained, and covered for an hour, they were spread out to dry at room temperature. When dry, two, 100 seed samples of each variety were placed to germinate on the top of moist sand, in flats, in the laboratory. Each succeeding week, samples were taken and germinated in the usual manner. The seed was stored in open flasks in the laboratory, at room temperature.

As a result of this experiment, it was noted that the hulled varieties of oats were not injured by storage for a period of nine weeks. The Liberty oats and the Marquis wheat, however, were injured to a marked degree when stored only for one week. This injury increased until after four weeks storage, when the percentage of germination was slightly better.

The writer is of the opinion that the hulled varieties can be stored, after treatment with formalin, provided they are dry. This was observed to be the case in later experiments, when the seed was treated with different must treatments, and stored for a period of ten months. The Liberty oats appear to be too sensitive to formalin to allow being stored after treatment.

Comparison of the Effects of Different Smut Treatments.

The purpose of the following experiment was to determine and compare the effects of different smut treatments for oats on germination, with special reference to seed injury.

Methods of Treatment.

Dip Method. The seed lots were dipped in a formalin solution of 1 pint of formalin to 40 gallons of water for ten minutes, drained, covered for an hour and spread out to dry at room temperature.

Sprinkle Method. The seed lots were sprinkled with the formalin solution, of the above strength, at the rate of 1 gallon of the solution per bushel of seed. The seed was covered for four hours, then spread out to dry in a thin layer.

Spray Method. Each seed lot was sprayed with a formalin solution, at the rate of 1 pint of formalin to 1 pint of water to 50 bushels of seed. After treatment the seed was covered for five hours, and then spread out to air to allow the escape of any remaining formaldehyde gas.

Copper carbonate Method. The seed was shaken in a bottle with copper carbonate at the rate of 2 ounces per bushel of seed, until each seed had a covering of the dust.

Uspulun Method. The seed was soaked for two hours in a .25 per cent solution, drained, and allowed to dry.

One set of seed of each treatment, was placed to germinate on moist sand in flats, or planted in soil in flats, kept at room temperature. Dry storage of treated seed took place in the laboratory.

The rate and method of germination was observed until the tenth day after planting, when the final count was made.

It was observed, from the germination tests carried out in this experiment, that the different formalin treatments had little or no injurious effect on the germination of the hulled varieties of oats, although stored dry for a period of ten months. It was noted with all the formalin treatments, that, in some cases, there appeared to be a retardation of the radicles of the treated seed, compared with those of the control sets of seed. The plumules of the treated seed emerged quite as readily, and appeared to be as high in vitality as those of the control.

The hulled varieties were not reduced in percentage of germination by the copper carbonate treatment. A slight retardation, rather than any stimulative action, was observed to occur in the treated seed germinated at the end of ten months.

The Uspulun treatment was not observed to injure the hulled varieties of seed, although treated seed was dry stored for a month. No stimulative action of the treatment on the seed was apparent.

The Liberty oats were injured by all of the formalin treatments, although germinated immediately after treatment. This injury was increased by dry storage for one week. Ten months dry storage, however, did not produce a corresponding amount of injury of the treated seed.

The copper carbonate treatment did not reduce the percentage of germination, but after ten months storage slightly increased it. No retardation of germination was observed to occur.

The Uspulun treated seed emerged ahead of the controls, produced a much stronger growth, and germinated with the highest percentage. There appeared to be a distinct stimulation due to this treatment, instead of marked injury as with formalin. Dry storage for a month did not have any injurious effects on the germination the treated seeds germinating with a higher percentage than the controls.

A comparison of the root systems of the seed, treated by the different methods, revealed a similar condition to the tops. The Uspulun treated seed had the greatest development of roots.

All of the formalin treatments, from the experiments carried on, appear to be equally safe with the hulled varieties of oats, and equally injurious to the Liberty oats. As a means of reducing, or preventing, seed injury to the Liberty oats, both the copper carbonate and the Uspulun treatments are worthy of note. The writer considers that the Uspulun treatment is the better one, because of the apparent stimulative effect on germination which it produces.

SUMMARY.

As result of work carried on with three varieties of hulled oats, and one hull-less, to determine the effects of formalin, copper carbonate, and Uspulun on germination, it was found that:

1. The hulled oats could be subjected to the formalin treatment necessary for smut disinfection without injury occuring to germination. Dry storage for several months did not induce seed injury.

2. The Liberty oats were seriously injured by the different methods of formalin treatment for smut. Dry storage after treatment increased injury.

3. With the Liberty oats, the temperature of the formalin solution was found to be a factor in the production of injury.

4. Presoaking the seed in water before the formalin treatment was found to reduce seed injury with Liberty oats.

5. The characteristic type of injury due to formalin treatment was observed to be a retardation in emergence or a killing of the radicle, rather than injury to the plumule.

6. Dipping the seed in a milk of lime solution after the formalin treatment was found to be distinctly advantageous in reducing seed injury.

7. Copper carbonate did not reduce the germination of the hulled oats.

8. The germination of the Liberty oats when treated with copper carbonate was usually as good as the control.

9. Oats treated with copper carbonate and dry stored for several months were not reduced in germination.

10. Uspulun was found to be non-injurious to the germination of the hulled oats. It appeared to be a stimulant to germination in the case of the Liberty oats.

11. Oats treated with Uspulun and dry stored for a month showed no reduction in germination.

This article is an abridgment of a thesis taken under Dr B. T. Dickson in the Department of Botany, Macdonald College, and submitted to the Graduate School of McGill University in partial fullfilment of the requirements for the degree of M. S. C.

The writer wishes to acknowledge with gratitude his indebtedness to Dr. Dickson for the many valuable suggestions and helpful advice given him during the course of the investigations. In addition he wishes to express his thanks to the Agronomy Department, Macdonald College, Que., and to the Cereal Division, Central Experimental Farm, Ottawa, Ont., for the seed oats and wheat used throughout the experiments.

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A PRELIMINARY NOTE ON SOME ENDOPHYTIC PROTOZOA.

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The first record of a protozoon parasitic in plants was made by Lafont in 1909, when he and his assistant David discovered in Mauritius a flagellate parasitic in the latex of *Euphorbia pilulifera.* Lafont named this organism *Leptomonas davidi,* and two years later announced that a hemipterous insect *Nyssius euphorbiae* is responsible for its transmission. Since that time several workers have contributed to our knowledge of *L. davidi*—its morphology, hosts and method of transmission. Other workers have shown that this is not an isolated case but that many other lactiferous plants, belonging to several unrelated groups, carry flagellates and amoebae in their latex. In this connection special mention should be made of a series of excellent papers published by G. Franchini of the Pasteur Institute of Paris.

In the summer of 1923 the writer commenced a survey of the lactiferous plants in his vicinity, and was gratified to find flagellates or amoebae constantly present in several species of indigenous and exotic plants. The following plants

have been studied more particularly: *Asclepias syriaca, Convolvulus sepium.,* Norus alba, *Lactuca canadensis, Apocynum sp., Lactuca sativa Hieracium aurantiacum, Taraxacum officinale Ficus sp. Sonchus spp., Euphorbia sp. Chelidonium majus.* Evidences of the presence of protozoa have been found in certain other plants but no detailed study has yet been made of these. No description of these organisms will be given in this preliminary note, as the writer is engaged in the preparation of a series of longer papers on the subject.

In addition to its intrinsic interest to the protozoologist, the study of this subject may possibly throw new and important light on certain phases of applied pathology. In the first place many plant pathologists are convinced that protozoon-like organisms may be concerned in the etiology of certain obscure diseases of plants. In the second place, there is a close parallel between the relations of these organisms, which are probably primarily insect parasites, to their plant hosts, and the relation of similar insect parasites to their secondary vertebrate hosts. It has already been suggested that plants may serve as the reservoirs of certain human diseases. Franchini has shown that several pathogenic human protozoa will live and grow in latex. He has also succeeded in inducing infection in white rats by inoculating them with protozoa derived from the latex of plants. At the Cincinnatti meeting of the American Association last December, Dr Richard Strong announced that one of these plant parasites, having passed through the body of an insect and a reptile, is capable of parasitizing mammals.

Leptomonas davidi is associated with a definite gummosis of Euphorbia. In none of the plants which I have studied have I be enable to detect any disease symptoms indubitably associated with the presence of protozoa. In most cases the plants are outwardly healthy, and where parasitized plants show disease symptoms a connection between these symptoms and the presence of protozoa has not been established since plants of the same species are found heavily parasitized without showing any lesions.

The organisms apparently pass the winter as minute resting cells, in the stems of shrubs or in the overwintering roots of herbaceous perennials. In two flats of *Hieracium* grown in the greenhouse during the winter, the organism remained in the resting stage in the latex in all parts of the plants. The plants were very robust and healthy but there was no appreciable growth until the approach of spring. With the commencement of growth in the plants the parasites also began to elongate and assume the active condition. Tropical plants growing, in the greenhouse contained active protozoa in their latex throughout the winter. There is evidently then a rhythmic adaptation between the endophytic protozoa and their hosts.

In two cases, *Asclepias syriaca* and *Convolvulus* sepium., the writer has discovered that the organisms, a flagellate and an amoeba respectively, may pass into the seed in the resting stage and later infect the seedling. This, together with the adaptation mentioned in the preceding paragraph and the apparent absence

of injury in at least some cases, points to a long continued association between the protozoa and their plant host.

L. davidi has been shown to complete its life cycle in certain hemipterous insects. Most probably the forms which I am studying are also associated with insects. Preliminary studies have been made but I have not yet succeeded in establishing the identity of the forms studied with any of the numerous flagellates to be found in the insects which attack the infected plants.

THE LIFE HISTORY, HABITS AND CONTROL OF THE LESSER OAK CARPENTER WORM.

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For several years past, the red oaks in certain areas of the Ottawa Valley have been attacked by a destructive, lepidopterous, wood-boring larva, *Prionoxystus macmurtrei* Guer.-Men., commonly known as the Lesser Oak Carpenter Worm, which has caused considerable injury to the trees and been responsible for much loss.

The caterpillar feeds upon the red oak almost entirely, its tunnelling work being carried on extensively within the bark and sapwood, and later on into the inner heart wood of this handsome shade tree, where it takes the form of deep auger-like holes through which rain water and fungous spores often find entrance.

The economic importance of this pest made it of special interest; hence a detailed study of its life-history and habits was considered worth undertaking.

GENERAL PLAN OF WORK AND METHODS

The place where the work was carried out was at Queen's Park, a small wooded area in extent between sixty-five and seventy acres, situated on Lake Deschênes about two miles west of the town of Aylmer, Que., and about ten miles north-west of Ottawa city. The trees in the park for the most part were red oaks, although there was a good supply of bur oak, maple, basswood, blue beech, poplar, birch, cedar, white pine, spruce and balsam. Numerous evidences on all sides pointed to the fact that the Oak Borer had been at work for some considerable time. Many of the trees were badly scarred and showed ugly bulging trunks; others had become rotted at the base; while the majority had larvae working in them, as shown by the fresh piles of saw dust seen around them. The conditions therefore for making this study were vera favourable.

Field work was begun in the autumn of 1918 and continued throughout the summers of 1919 and 1920, supplemented by observations made in 1921 and 1922.

Three main plots were marked off, two for control and the third for life history studies. All trees were numbered. At first, identification tags of cartridge paper were used for this purpose; but these attracted too much public attention and were often as a consequence, torn off by curious visitors. Stencelling the trees in white lead, however, proved quite satisfactory. Large round tobacco tins were used to catch the adults and to collect frass. The bottom of each tin was first removed; sides split up about an inch all around with a shears; the cut parts turned outward at right angles to the sides; the tin then nailed on to the tree over the hole where frass was issuing and the top put on. Banding the trees with wire cloth was found unsatisfactory as the specimens became mutilated on account of entanglement in the netting, and in some cases were destroyed by ants.

The plots were visited daily throughout May and June to determine the date of emergence, obtain adult and pupal records and remove empty skins from the deserted burrows as they were discovered. The larval borings were cleared from the entrance of the tunnels by means of a long-haired brush.

Several experiments in egg deposition under more restricted conditions were carried out at the Divisional Field Laboratory which was situated closed to the park, the results of which appear further on. Notes were kept on the hatching of all eggs, both in the laboratory and in the field, as well as on the habits of young caterpillars and older larvae at work within the wood. During the winter the plots were visited and special trees felled for the purpose of locating the positions of the hibernating larvae and obtaining other data.

A great many photographs were taken; also drawings, charts and tables made, some of which have been used to illustrate the text.

DISTRIBUTION

P. macmurtrei is confined for the most part to Eastern Canada and the Atlantic States but has been taken as far south as Texas. (U. S. Bull. 3, Div. Entom., p. 5.) The western limit appears to be Minnesota.

Its host, as shown from Canadian records is the oak. It has been briefly recorded from chestnut in New York State Museum Report for 1919, on page 516 as follows: "*P. macmurtrei* Guer.—Larva in oak and chestnut." In Fracker's "Classification of Lepidopterous Larvae" on page 78, this short, very indefinite note appears:—"*P. macmurtrei* bores in a number of different trees." Felt, in Memoir 8, N.Y. St., Museum, Vol. 2, page 439, devotes half à page to a description of *P. macmurtrei* and makes the following brief note; "bores in black oak". Apart from these three references, no host other than oak is recorded in the scanty literature available on the subject.

THE HOST TREE

Before beginning a discussion of the bionomics of *P. macmurtrei*, it may be well to give a just brief account of some observations and field notes made by the writer on the characteristics, habits and economic status of the host tree.

The Red Oak, *Quercus rubra* Linn., is a native of Canada and has a range of growth extending from Nova Scotia and New Brunswick to the west of Lake Superior. It is a handsome, straight-trunked tree, branches well and affords good shade. It appears to favour a great variety of soils and conditions,

specimens being found about Aylmer, Que., thriving in low, damp places, as well as on the higher more exposed and rocky localities. It is the most rapid grower of all our oaks and reaches a height of over sixty feet with a diameter usually three feet in extent, and sometimes more. The bark when young is quite smooth, thin and glossy, and will remain so after the tree has attained a considerable size; but as age increases it tends to become cracked and roughened. While slow to leaf in the spring, it will retain all its foliage until late in the fall when the leaves become a brillant red, presenting an object of picturesque beauty not exceeded by any other tree except the red maple, *Acer rubrum* Linn. The leaves are oblong and needle-pointed, with wide oblique sinuses; smooth and firm in texture; a bright pink when first unfolded but turning dark green later. The acorn which is oval and stands about one inch high is inclosed in a shallow cup and is quite bitter to the taste. It requires two years to mature. The wood is reddish in colour, of coarse grain, porous and not very durable; the chief uses being for cooperage, interior finish and the cheaper furniture.

The red oaks have many excellent qualities to commend them for planting on public thoroughfares, on highways of the country side, and on the streets of cities and towns. From a stand point of beauty and shade they are much to be desired. They are also very hardy and grow rapidly under city conditions which often-times are very injurious to tree life, showing a considerable tolerance for such harmful agencies as smoke, gases, dryness and root constriction. They also have the advantage over many other species of *Quercus* in being free, to a considerable extent, from many of the commoner insect pests. In view of these facts it seems strange they are not used more frequently to shade residential streets and beautify the parks and gardens.

There are two species of oak growing in the park; the Red Oak, *Quercus rubra* Linn., and the Bur or Mossy Cup Oak, *Q. macrocarpa* Michx. The former which is in greater abundance than any other tree in the district is well distributed and in fairly good stands. Of these two, the Carpenter Borer attacks the red oak only. This partiality is specially noticeable in certain places where both species are growing side by side. A large number of the trees show injuries directly attributable to the work of the larvae which excavate large areas in the outer bark and tunnel deep holes into the wood. Through these, rain water and fungus spores often find a ready entrance and cause further deterioration of the host. Fortunately, the species possesses quite a remarkable power to reccuperate and can quickly repair its injuries, as shown by the numerous healed scars on the trunks and branches. This beneficial characteristic is responsible for many of the trees surviving the severe attacks made upon them. Nevertheless, there is considerable mortality and a large number are in a very poor condition with tops dying downward and branches being killed back gradually.

In several places much coppice growth has been formed. This is another common habit of the species. Groups of three, four, or more trees will be found growing from a common centre so as to form a hollow in which the water settles, creating in this way favourable conditions for the establishment of rots and fungi.

SYSTEMATIC POSITION

The interesting family Cossidae to which this insect belongs, forms a distinct group of the Order of Lepidoptera, the members of which are characterized by the wood-eating habits of the larvae. It includes such well known pests

as the Goat Moths, the Leopard Moths, and the Carpenter Moths. The popular term Carpenter Worm has been applied particularly to the members of the genus *Prionoxystus* because of the very large, augar-like borings that these larvae make in the wood.

The genus *Prionoxystus* is a small but important one containing only two species, *robiniae* and *macmurtrei*. It has been known by other names, such as *Xyleutes*, *Cossus*, etc. That of *Xyleutes*, signifying carpenter, as preposed by Hubner, was certainly a fitting one for the boring larvae. The word *Cossus* has an interesting historic association. It is derived from the Latin form *cossus* meaning "a worm bred in wood".(1) According to Pliny, the historian who was a close student of many branches of natural science, the ancient Romans popularly applied the term *cossus* to an oak borer which they were accustomed to rear for the purpose of food, it being considered by them a highly palatable dish. In the course of his "Natural History" which is an encyclopedic account of the knowledge of his times, Vol. 1, Book 17, Chap. 37, Sec. 4, p. 643, he writes as follows: "Certain trees are infested with worms to a greater or less extent, almost all indeed. And this fact birds test out by the sound of the hollowness of the bark. Indeed nowadays they are beginning to be sought after and the especially large ones from oaks are esteemed a delicacy. They are called cossi and are actually fattened up specially with meal." In another place, Vol. 11, Book 30, Chap. 39, Sec. 3, p. 341, Pliny further records the fact that the Romans also used these borers medicially. This is what he says: "The cossi which are engendered in wood heal all ulcers; they are burnt with an equal weight of anise and daubed on with oil." It is most likely, however, that the word cossus was employed for the first time in scientific literature by Linnaeus in describing the European Goat Moth in 1758, which he named *Bombyx cossus*. . Fabricius, at a later date, 1794, when describing the insect gave it the name *ligniperda*, wood destroyer, and created a new genus on which he bestowed the name *Cossus*. In this genus *macmurtrei* was placed by Guerin in 1829 when he originally figured the lesser-oak carpenter moth. Kirby in his "Catalogue of Lepidoptera" 1892, put it in the genus *Trypanus*, while Neumaegen and Dyer in their "Preliminary Revision of the Bombyces" in 1894 arranged it under the genus *Prionoxystus* which Grote had established in 1882. When Fitch was studying the same insect in 1859 he called it *querciperda* and classified it under the genus *Cossus*. Lintner did the same in 1878. Grote in his new Check List 1882 accepted Fitch's *querciperda* but placed the species under *Prionoxystus*. Barnes and McDunnough in their "Contributions to the Lepidoptera of North America" have classified it under *Prionoxystus macmurtrei* the same as Neumaegen and Dyer. This name is now accepted as the correct one, the others having passed automatically into synonomy.

DESCRIPTION OF THE INSECT.—THE ADULT

The *female* moth is 32 mm. long and 10 mm. at widest part of thorax; with wing expanse of 60mm. It has a spindle-shaped body, rather thinly covered with darkish grey scales and of that peculiar combination of shades known as "pepper and salt". On the mottled fore wings appear black lines running across the principal veins nearly at right angles, while the hind wings are clear, except for a shaded area nearest the body. The head, which is somewhat prominent,

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(1) See Ainsworth's English-Latin dictionary 1840 p. 124).

supports a pair of delicate antennae, comb-shaped to the tips. Unlike many of the larger moths, such as the sphinxes that are provided with long tongues and complicated sucking tubes for obtaining their liquid food, the carpenter moths are without mouth parts, or these organs are so atrophied as to be of no use, and food is therefore unnecessary.

The *male* moth is very small being 16mm. long; 6mm. wide and 35 mm. across the wings. It bears little resemblance to its heavy-bodied, lethargic, grey-winged mate, and at first sight may readily be mistaken for some other species. A closer inspection, however, shows it to possess certain characters in common with the female. The head is without mouth parts, the antennae are comb-shaped and small spur-like projections appear on the hind legs. The front wings are clear and shining with only traces of the transverse markings which are so noticeable in the female; while the under pair, for the most part are clear and have the extreme outer margins dark-banded, with a small shaded area on the inner sides nearest the body. Viewed in certain lights a decided sheen can be readily detected on the surfaces.

TECHNICAL

Female. Body length 30 to 32 mm., breadth 8 to 10 mm.

Colour, dull cinereous; head prominent; antennae bipectinate; mouth parts obsolete; thorax well rounded dorsally; vestiture rather sparse, scaly, showing body beneath to be piceous, glaberous and shining; abdomen large, cylindrical and rather thinly covered with grey scales; hind tibial spur reduced; wings translucent, reticulated, primaries crossed transversely by a number of black lines and have their outer margins opaque; frenulum rudimentary; alar expanse 60 mm.

Male. Body length 16 mm., breadth 6 mm.; colour, darker shade than female; slimmer in body proportionately, and shining when scales are removed. Vestiture very sparse; primaries thin, hyaline, with traces of transverse lines; secondaries immaculate, except when viewed from the side, a faint orange-yellow tint is then detected; inner margins dark, outer edges black; alar expanse 30 to 35 mm.

COPULATION

There were several occasions on which mating was observed. On June 14th, 1919—about 9.45 a. m. a large female that had just emerged was noticed at rest about five feet up on the trunk of a red oak. The moth was exposed to the full sunlight and its cream-white two-jointed ovipositor considerably extented. Presently a male appeared quite suddenly. He flew in towards the tree where the female was resting, with a sharp vibrating hum. As he rapidly circled the oak his presence was evidently recognized because the female at once became active and thrusting out her ovipositor further, immediately rejected a quantity of thin, white fluid. The male promptly landed near by upon the bark and with much fluttering of wings rapidly approached and backing formed a union. The female shortly afterwards began to crawl up the bark, dragging the male after her. Unfortunately, the pair came in contact with one of the tin traps used on the trees, and trying to cross the smooth surface lost their foothold and fell to the ground, separating so quickly that it was impossible to secure the male before he got away. The female was placed back

upon the tree and she at once began to oviposit. Some of the eggs were laid upon the smooth bark, others about the edges of the tin, but most were stored away in crevices and cracks, eight, ten and more, tightly wedged together.

There were three or four pairs of moths placed in glass cages at the laboratory for egg records, etc. No evidences of mating were noted in confinement, although the males frequently were active, circling around and keeping up a high beating hum with their thin parchment-like wings, only to be totally ignored or pushed aside. After a day or two the males died, but the females lived for eight or ten days longer to oviposit. Egg records in this connection will be found tabulated below.

Females enclosed in wire cages in the open were frequently visited by males, and several were caught in this way. There were also occasions where males were noticed on the outside of the wire screen of the insectary. Likely they had been attracted there by the females within.

EGG

The egg is somewhat oval in shape, averaging 2.34 mm. in length and 1.78 mm. in width. The whole surface of the chorion is heavily, irregularly reticulated, except at the poles where a small circular area is free from these markings. When first laid they are dull greenish-yellow, but later this colour changes to a full brown with suggestions of a greenish tint in some instances, and in others a dark muddy-yellow.

OVIPOSITION

This begins shortly after the female has emerged from the pupal case. The moth starts by carefully examining the surface of the logs or trunk which it is on, testing every crack and crevice of the bark, and by means of the long ovipositor which is quite freely used, it endeavours to find some convenient spot to place a batch of eggs; then extending the ovipositor deeply into the crevice will pack away two, three, four and even more eggs according to the size of the cavity. In some cases as many as twelve have been counted tightly wedge together. After deposition in one place the moth will move to a fresh site and repeat the operation. Occasionally, it stops awhile as if to rest, then starts up again. A clear viscous liquid is often present in sufficient quantities to moisten small spots on the wood surface. This, is likely, used for glueing the eggs to the bark as it was never noticed except during oviposition. When depressions, crevices or such hiding places are not accessible, eggs may be laid indiscriminately upon the smooth bark, or in small groups more or less irregular in number and scattered.

All the eggs are not expelled at one time· usually a week will cover these activities. The laboratory daily records in this conection show a sharp curve upwards, then a gradual decline. The number of eggs per female varies considerably from 50 to over 275. From two unfertilized females which were dissected, 74 and 132 ova, respectively, were taken in advance stages, with many smaller ones and a number in the early embryonic formations which were not counted.

Dr. James S. Bailey in U. S. Bull. 3, Div. Entom. p. 53 briefly remarks as follows:—"*Cossus robiniae* Peck and *Cossus querciperda* Fitch have been known to extrude upwards of three hundred ova". It may be safe, therefore, to place two hundred and fifty eggs as a fair average per female. The female dies almost at once after oviposition has terminated.

Egg Laying Records.—*P. Macmurtrei.*

Date 1919	Cage 1.	Cage 2.
June	female put in cage at noon oviposition began at 1.30 p.m.	female put in cage at 9 p.m. oviposition began at 11 p.m.
10	68 eggs at 10 p.m.	
11		
12	85 eggs at 6. p.m.	79 eggs at noon.
13		
14		
14		45
15	48	
16		
17	1 female died	42
18	TOTAL DEPOSITION—220	female died TOTAL DEPOSITION—166.
19		
20		
21	Hatching began at 10 a.m.	Hatching began 10 a.m.
22	123 hatched by 7 p.m.	22 hatched by 7 p.m.
23	1	4 hatched by noon.
24	No records taken	No records taken.
25	12	35 at noon.
26	5	4 at noon.

Egg Laying Records.—*P. Macmurtrei.*

Date 1919	Cage 3.	Cage 4.	Cage 5.
10	June female put in cage at 7 p.m. oviposition began in night.		
11	15 eggs at 9 a.m.	female put in cage p.m. oviposition began at 5 p.m.	
15	6 semale died	9	
16	TOTAL DEPOSITION—51		
17		1	TOTAL DEPOSITION—125
21	Hatching began		
22	17 hatched by 7 p.m.	61 female died	
23	2	TOTAL DEPOSITION—71	
24	No records taken.		

Summary.

CAGE	TOTAL DEPOSITION	
female No. 1	220	
" 2	220	166
" 3	166	51
" 4	71	71
" 5	125	125

Oviposition in Laboratory began June 10
Hatching " " " " 21
Oviposition " Field " " 14
Hatching " " " " 27
Incubation period in Lab. 10 days.
" " " Field 13 "
Average period of deposition 7.5 "

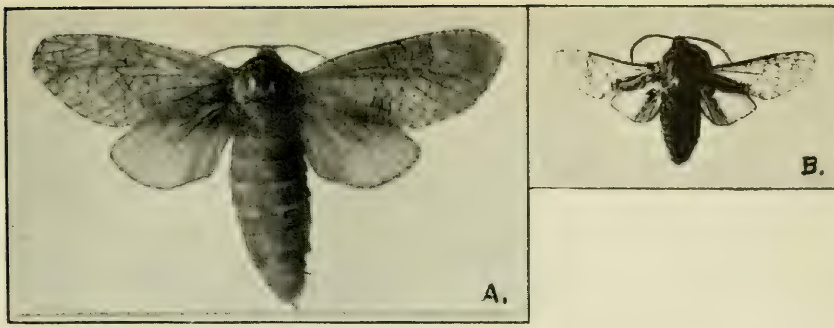

Fig. 1.—Moth. A. Female.—B. Male. Natural Size (Original).

Fig. 2.—Eggs enlarged 14 times (Original).

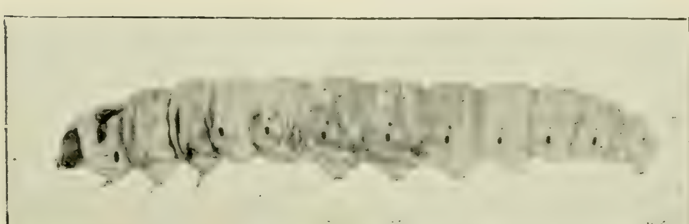

Fig. 3.—Full grown Female Larva (Original).

Fig. 4.—Red Oak Log split to show Larva tunnels (Original).

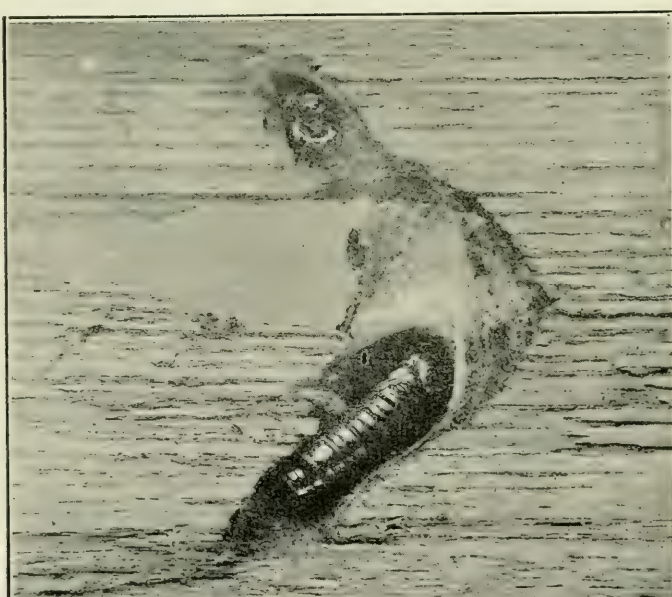

Fig. 5. Pupa in situ (Original).

HATCHING

A large number of eggs were laid loosely upon the surface of oak sticks placed in cages where the gravid females were confined. The following observations relate to the hatching of these eggs rather than to those deposited in the field.

Incubation occupies ten to thirteen days. When ready to emerge the young larva starts to cut its way out by nibbling a minute opening in the shell. This is enlarged quickly from a small circle to an irregular hole, the larva working at one edge of the aperture. The head is then partly pushed out and the work of cutting away the chorion goes on while the body within is gradually uncoiled, the legs being used vigorously to assist in the process. It is a matter of only a few minutes before sufficient of the shell has been cleared away for the head to emerge entirely, and once this is done the larva proceeds to draw out the rest of its body by short spasmodic struggles, clinging closely to the exterior of the shell as it goes. It now begins to lay down a fine silken thread from the egg case to the bark and at once becomes very active searching for cracks or hollows nearby in which to enter. The time taken to emerge completely, from the moment the first mark on the shell was observed until the larva was outside, averaged twelve minutes.

LARVA

The average larva on hatching is 5.5 mm. long and 1 mm. wide. The head is dark and the thorax dull reddish-brown; the body is flesh-coloured on the dorsal side and dull white on the ventral. A number of single, fine hairs appear over the body situated laterally, several of extra length being on the head and anal segment.

By the end of the first season the larva has attained a length of 20 mm. and width 3.5 mm. The head is black and shining, the body pink in colour and marked with a number of tubercles of a darker shade of pink. From each of these a short fine hair arises.

Larvae of the second season show considerable change in length and colour scheme. The following is a description of a larva, likely a female, taken from its 2nd year's hibernating quarters early in April 1921. Length 37.0 mm.; width 6.0 mm.; head dark reddish brown and shining, retractile. Prothoracic shield light brown with transverse crescent markings on the dorsum of the meso-thorax and meta-thorax. Two pairs of hairs on each side of thorax. Abdomen faintly pink, each segment bearing six reddish tubercles, four on the dorsum which are arranged trapezoidally and one on each side near the spiracle. Anal segment brown, true legs reddish brown, tarsi brown with dark hooks; prolegs same colour as body, fringed with red hook-like attachments.

A description of a specimen, probably a male, dug out of its second winter's resting place, on March 1st, 1921, is as follows:— Length 25 mm. approximately; width 5 mm. (broadest part of thorax). Head and mouth parts black, shining, smooth, with few scattered hairs standing erect. Head retracting into thorax. Thorax dull yellowish-brown, the meso--thorax and meta-thorax gradually tapering to meet the first abdominal segment. Each bears a brown lunar marking, the cusps of which point toward the head. Abdomen is bright pink or dorsum, except anal segment which is pale yellow and about the same colour as the venter. Segments are well divided; each has four large, round,

slightly elevated, dark brown tubercles, trapezoidally arranged, situated laterally and above the stigmata, in the centre of each segment, is a brown tubercle; and beneath the stigmatal opening another tubercle, not so well defined. Each of these wart-like bodies has a long, erect, fine, hair 3 to 4 mm. long, those of the final segments are somewhat longer and coarser. The true legs concolorous with venter, are three jointed, with tarsal claws sharp pointed and curved. The prolegs yellowish and fleshy, each with a fringe of reddish-brown crotchets pointing inward. They are situated on the third, fourth, fifth, sixth and tenth, abdominal segments. The breathing spiracles are large and prominent with outer edges coloured brown, placed laterally on each segment of the abdomen, (excepting the last two) about midway, with a tendency cephalad. This is more pronounced in the anterior segments. The prothoracic stigmata are situated well down near the transverse posterior margin of the segment, one on each side.

The full grown female larva is readily recognized by its size. It is a thick fleshy grub, dull greenish-white in color and reaches a length of 65 mm. and width 17 mm. The head is light mahogany and recedes into a hood-like, prothorax which is slightly coloured with brown; mouth parts dark; mandibles large and horny. There is a group of three spines immediately in front of the prothoracic spirale. In first stage larvae, however there are only two in the group. This characteristic is very distinctive of the cossid larvae. Both mesothoracic and meta-thoracic sections have transverse lunar-shaped markings, that of the former being more pronounced. The coloured tubercles so noticeable during the first and second years are now very indistinct. The two spines situated just under each abdominal spiracle are arranged close together; this is peculiar to the genus *Prionoxystus*. The prolegs are large and fleshy, each bearing an oval crown of coral-red crotchets which are arranged in a circle facing inwards. These crotchets are triordinal, that is, they are of three different lengths. The anal segment supports two fleshy processes which have a semi-circular fringe of red crotchets, also triordinal. The heart flow can be very plainly seen beneath the pale skin.

The measurement of a number of head capsules suggests the likelihood of five moults.

Approximate measurements of larvae, according to sex, to indicate the development at end of each season.

Male		Female	
1st season growth from	5 to 15 mm.	1st season growth from	5 to 20 mm.
2nd " " "	15 to 25 mm.	2nd " " "	20 to 45 mm.
3rd " " "	25 to 36 mm.	3rd " " "	45 to 65 mm.

Average Pupal Case for male —	45 mm.
Average male Larva —	65 mm.
Average Pupal Case for female —	25 mm.
Average female Larva approx. —	36 mm.

LARVAL HABITS

The larva on hatching usually enters the bark at a point just below the egg; but there were instances where this did not occur. Instead, the larvae remained congregated on the surface beneath the batch of empty shells, actively laying down fine webs and exhibiting signs of unrest. This work went on for a day or two and gradually ceased as the larvae burrowed into small crevices near by.

One of the most reliable signs of early larval operations is the presence of small quantities of brown sand-like casting held loosely together by invisible threads of silk. These castings may be found chiefly in the bark crevices and about the creases of callous formations. Another indication is a discoloured spot on the bark, somewhat circular, from a quarter to one half inch in diameter, with a darkened centre from which sap may be oozing.

Thus established the young borer begins slowly to extend the very small cavity, enlarging it slightly as it proceeds inwards through the bark tissues. The space cleared in this way by the end of the summer will be about an inch or so in diameter, depending upon the character of the bark, that of younger trees being softer and more succulent, and the boring itself not deeper than three eighths to one-half of an inch. Here in this small gallery the larva spends the first winter. Next spring, about the early part of May, it begins to extend the site of the first year's operations and not only will bore deeper but also widen its tunnel and chisel it irregularly back and forth in the inner bark and outer layers of wood. Often two or three larvae will be working together in one of these galleries and will clean away and skeletonize an irregular area of several inches across with branch tunnels leading off in various directions. It is during this stage of larval activity that much serious damage is done. large boughs sometimes being girdled and trunks badly disfigured on their surfaces.

As summer progress the larva continues inwards and attacks the outer rings of the sapwood, passing on to the harder material of the heart-wood where it hibernates. One larva dug from its winter quarters was curled in the shape of the letter S, that is, the anterior segments of the body were bent over towards the back, and the posterior ones turned inward over the venter. The creature appeared lifeless when removed, and for some time afterwards, efforts to arouse it were without effect. On bringing it indoors, however, it revived and moved about actively. Other specimens taken from their winter cells in the outer woody rings exhibited this curvature of the body, some showed this more than others, for the most part at the abdominal end.

The following spring, the beginning of the third year period of the larva, the boring operations now having reached the heart-wood are carried further inwards, often with a tendency upwards. After proceeding in this way for an inch or so the larva in many cases will turn and tunnel straight upwards into the very centre of the tree, returning from time to time to the mouth of the tunnel to remove excrement pellets and boring dust, and also to cut back the tunnel walls in order to provide the necessary accommodation for its growing body. By the end of the third summer the entire gallery will be about the same diameter from end to end and excavated to a distance of twelve inches or even more from the point of entry. In September the larva prepares for pupation. In this state it spends its last winter; but if for any reason it should hibernate as a larva, as sometimes happens, emergence will be delayed the next summer.

Occasionally, an exit will become blocked in some unusual way. A pupa endeavouring to reach the exterior will be unable to do so. This contingency

however, will be met when the larva visits the mouth of the tunnel, previous to pupation (as it were to insure that everything is in readiness) and should the passage be blocked it will cut away obstructions and remove all debris, leaving a clear exit for the spined pupa, later to wriggle its way through to freedom. This natural provision while not peculiar to *P. macmurtrei* is note worthy when it is considered that the adult is without mouth parts and helpless to liberate itself in the event of meeting any serious obstruction. During the summer of 1920 two instances of this nature were recorded. It was noticed that the entrance of these particular tunnels had become blocked from the exterior by the natural growth of another tree which had intersected with the host just at the point of entrance. The character of the frass being expelled from narrow slits led to the belief that pupation was to occur soon. Both exit holes were watched with particular interest. One morning soon after the borings had ceased each tunnel entrance was found freshly enlarged, the exterior rims being gouged away clearly as if cut by a sharp penknife and made wide enough to introduce the point of a little finger. This operation took placs at night, or early in the morning, and was not witnessed. In due time both pupal éases appeared and the adults were able to free themselves.

It is not an uncommon occurance for larvae to leave their burrows and wander about on the outside, even away from their host. They were observed to do this quite frequently. On one occasion a large grub was found upon the trunk of a white pine about 6 feet up. This nomadic habit which affects both the old and young borers is strange when it is considered that their natural habitat is within the narrow darkened galleries of the tree.

Infested trees often become a good base for further larval operations, forming what are known as "brood trees". Numerous observations lead to the conclusion that once the larvae have become established in a certain tree, some of the following generations will keep to the same oak and use the tunnels made by former occupants to carry on their boring operations deeper and higher up into the heart-wood. Under such an attack the tree is liable to become badly honeycombed and its interior converted into a labyrinth of sooty tunnels which cross and intersect in every direction. On the exterior the tree will heal its wounds by forming thick, horny, bulging scars around the large holes commonly seen on the trunks and which often contain sawdust, frass, rotten wood and other debris. Such conditions offer favourable openings for wood-rotting fungi, and it is not surprising that their spores find a fruitful ground for support and ready propagation.

Borings are often seen near the base of a tree. In cases where infestation has taken place previously in this region, the moth is likely to deposit there again. Usually the female being heavy bodied and clumsy, seems loath to move far from where she originally has emerged until rid of at least part of her burden; she may crawl up the trunk then into the upper branches, or fly to a neighbouring trunk and deposit the remainder of her eggs. The bark at the base is liable to be cracked, particularly in older trees, and show crevices somes distance up the trunk. These offer good locations for oviposition and are readily made use of, no part of the tree may be said to be free from attack, and even the small branches one inch in diameter, have been found intersected with larval burrows. In such, cases, girdling is apt to occur and the branch will break off or become a staghead. The killing back of the upper branches is very characteristic and quite common. Many of the trees have their symmetry completely ruined by these unsightly dead branches and ugly, gnarled, scraggy tips projecting from different parts of the foliage. The larvae also tunnel

Fig. 6. Moths in copula on Red Oak. Tin above for catching adults (Original).

Fig. 7.—Pupae.—A. Lateral view Female Case.—B. Ventral view Female Case.—C. Lateral view Empy Male Case.—D. Dorsal View Empty Female Case (Original).

PLATE IV

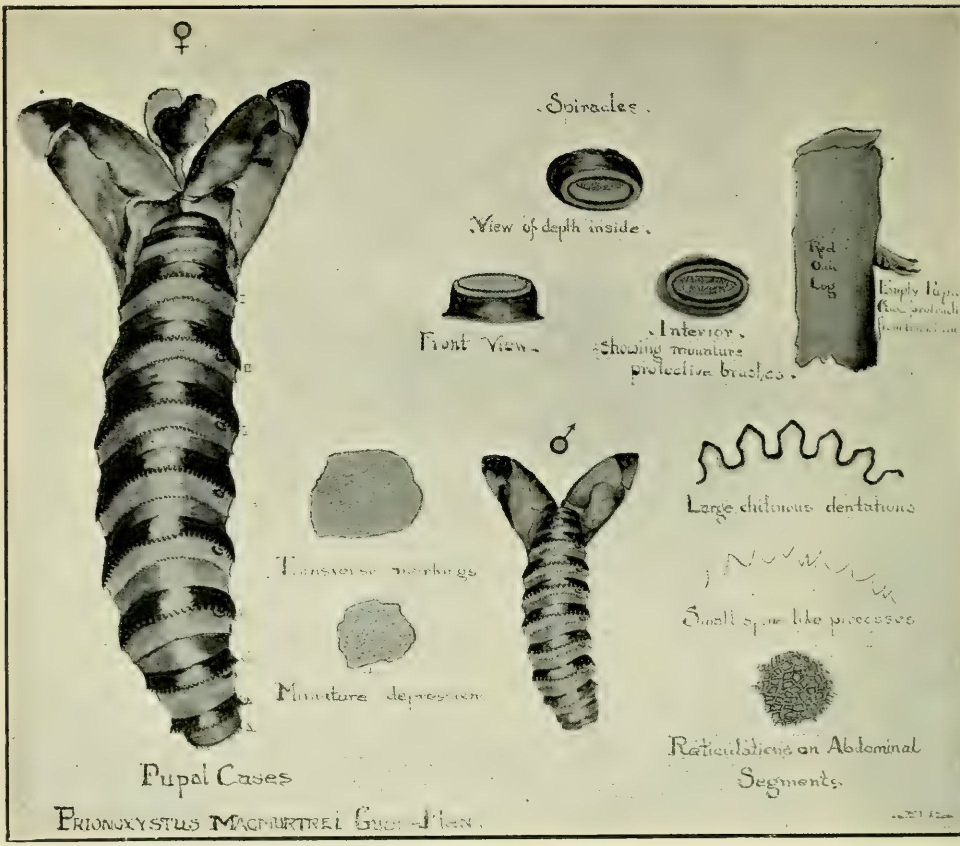

Fig. 9.—Pupal Cases, enlarged to show two kinds of spines and other external markings (Original).

Fig. 8.—Red Oak showing killing back of branches, a typical form of injury by P. macmurtrei (Original).

extensively in the larger boughs, often at the intersections with the main trunk, weakening these to such an extent that they readily crack and break down when swayed by a strong wind.

The following statement shows the number of scars per branch, found on one tree:

Branch.	Diameter.	No. of Larval Scars.	Branch.	Diameter.	No. of Larval Scars.
1	2½	7	7	4	7
2	3	7	8	2½	5
3	1	3	10	1	4
4	½	2	11	2	6
5	3	3	12	3	1
6	1	0	13	1½	3
				2	3
		18			
					29

Total No. of Scars—47
Average per Branch—3.6

The majority of these wounds were healed over and contained no larvae; judging from the rough chiselled incisions made by woodpeckers it is most likely the birds secured some of the grubs.

Silk Spinning.—Under natural conditions the larva spins its silk throughout the entire boring operations from the time of emergence from the egg until the final stage of pupation.

A young larva placed in a glass vial spun white, cobwebby patches of silk over the surface, almost excluding itself from sight.

The silk is mixed well with the frass in the tunnel, the fine threads holding this material together in clots and loose masses; especially is this noticeable in the pellet and sawdust varieties of castings.

Boring Frass.—Several kinds of boring material are turned out by the larva as it works its way from the outer bark to the wood within. By the character of the frass it expels, the progress or location of the larva within the trunk can be determined with some degree of accuracy. These castings may be described as follows :

1. Fine brown dust grains held loosely by invisible threads, thrown out by the very young larva when starting in a crevice.
2. A dark coloured, sappy matérial produced by the young larva within the outermost layers of the bark, during the early stages of excavation.
3. A dirty mixture of dark coloured and mushy-pulp matter, indicating the larva is entering or working in the sapwood.
4. Dry, white sawdust borings at the tunnel's entrance which have become mixed with coarse, dark pellets and droppings held together loosely by fine threads. This is a fair indication that the larva is excavating within the heart of the tree.

PUPA

The pupa is dark reddish-brown or mahogany coloured. It is well rounded and shining. The eyes, antennae, legs and wings are well seen beneath their thin chitinous coverings, the sutures being clearly defined. The female case averages 45.5mm. in length and 10.8 mm. in width; and the male 24.5 mm. long and 6.0 mm. wide. There is a decided curve ventrally at the posterior end of

the case in both sexes, beginning from segments 6 or 7, the abdominal segments being divided off by well marked sutural lines. These last support an armature of large and small barded processes on the dorsal side, which assist the pupa to reach the exterior. Each segment is divided into three areas, more or less distinct, and arranged as follows :

1. The first or anterior area, rather more thickly chitinized, has a row of coarse, broad-pointed, spear-shaped spines across its posterior border and is set with deep, rather coarse depressions.

2. The second or median area of thinner chitin has a row of fine toothed spines crossing its posterior border and a number of shallow elongated punctures, somewhat scattered.

3. The third or posterior area, a thin and narrow strip adjoining the median caudal border, is covered with a fine reticulation which likely provides for any expansion or contraction of the case.

The spines are placed transversely on the segments and point away from the head. Their arrangement is slightly different in each sex, the male carrying a row of finer spines on the 7th segment, whereas the female is without these. In both sexes the large coarse teeth are fairly regular in outline. The larger of these in each row are situated mid-dorsally and taper off gradually as they pass down, laterally, some distance beneath the spiracular line and in front of the spiracle on all segments except the first three. In segment 1 the entire row is absent; in 2 they terminate just above the spiracle; and in 3 they run to the top of the spiracle. There is a gradual increase in size of the larger dentations from 2 to 9 and also a corresponding irregularity in their form. The spiracles are large and quite prominent in both sexes, those of segment 8 being imperfect. They are tureen-shaped with outer edges smooth and rounded. The basal interior is lined with very fine bristles which when contracted pack together like two hair brushes tightly closing the aperture.

For a detailed study of the principal features of the external morphology of the pupal case of *Prionoxyotus macmurtrei*, by the writer, see 54th Report of Ontario Entomological Society, 1923.

Pupation.

Towards the end of September the larva begins to lay down a soft silk covering over the floor and walls, at the farthest end of the tunnel which has been gouged out and rounded smoothly like the bottom of a test-tube. Having done this it turns about, head outwards, and starts to erect a thick, grey, felt-like curtain, at a point about two inches from the extreme end of the cell, spinning this from the circumference inwards and finally closing same at the centre, thereby completely shutting itself off from the rest of the passage. Here the transformation occurs and winter is spent as a pupa. The following example may be cited here to illustrate the above: An oak was felled on September 29, 1920, and on being cut open, a full grown larva was discovered in the process of constructing its pupal bed. Fortunately, the log split in such a way as to show the whole cell very well. The chamber which was neatly, but rather thinly lined with silk had already been completed and the occupant was busy weaving the felt door which was only half finished at the time it was disturbed.

About the end of May or early in June, when ready to emerge, the pupa breaks through the felt curtain at the cell entrance and by a number of contractions and expansions of the abdomen it begins to move forward on its back out of the pupal bed into the tunnel. In this manner it makes its way along the

passage to the mouth of the burrow where it projects itself sufficiently to expose the head and thorax and perhaps a segment or two of the abdomen. The remainder of the case is held securely within the tunnel walls, anchored there by the numerous, sharp, chitinous dentations which protrude from each segment. Exposed to the air and free now to expand, the case quickly dries and cracks up along the clear-cut furrows enclosing the appendages; then by a number of violent pulsations. the head shell splits open and the moth quickly slides out from the case, pulling antennae, wings and legs from their covers, as it goes. The whole operation of emergence takes but a few minutes. As soon as liberated the moth expels a quantity of thick, white, liquid excrement, and crawling lazily on to the bark, proceeds to dry and stretch its wings. These are quite small, flaccid, and much crumpled when at first they come from their covers, but assume their naturel form in about fifteen or twenty minutes. When quite dry and fully stretched the moth folds them tent fashion over the back.

A good example is given here of protective coloration. The dark grey body of the moth, with its mottled wings, resting motionless on the roughened grey bark of the oak presents an object of natural camouflage which may deceive the eye of even a trained observer.

The moths emerge for the most part in June. A careful tabulation was kept of the adults as they came from the trees each day, by collecting the empty cases of the escaped imagines. About two hundred and fifty oaks were under observation and these were visited twice daily, morning and night. The first adult seen and pupal case collected was on June 4. On June 6 and 9 respectively, eight cases were taken, while on the 13th ten were gathered. This number then decreased rapidly until on the 29th one case only was found. Total of moths collected 59, in the proportion of 84.8% females and 15.2% males.

While it is the general rule for pupation to take place in the fall of the year, it would seem that this does not always occur at that period. On two separate occasions transformation did not take place until the following summer. The two particular instances referred to were under close observation and there was good reason to believe that the larvae were shortly to pupate, because the frass which had been observed issuing regularly for the past two seasons now began to be thickly matted and appear in very coarse pellets, a good indication that the tunneller's work was nearing completion. In due time this work ceased altogether and after a brief period of about three weeks both pupal cases appeared.

According to some investigators the larva makes its pupal bed near the mouth of the tunnel and in order to prevent parasites, ants and marauders from finding an entrance, it constructs a crude barracade of chips very near the exit through which the pupa forces its way later. . Field observations at Queen's Park for the past three or four years do not confirm this. The habit of forming a barrier of small bits of excelsior cut from the tunnel walls is commonly met with among certain members of the coleopterous larvae, as for example *Saperda calcarata* Say, and *Cyllene robiniae* Forst., but has not been associated with *P. macmurtrei.*

Emergences occurred under cover of night or very early in the morning, a fact which was substantiated by the adults and empty pupal skins being found only during the morning rounds. This arrangement has decided protective advantages, since a wriggling pupa, moth in process of emergence, or one moving

about on the bark in broad daylight may likely run considerable risk of attracting the attention of birds or other enemies near at hand.

METHODS OF CONTROL

Artificial.

Carbon bisulphide was tried as a control measure with satisfactory results. It was sprayed into the tunnels with an atomizer and the entrance holes stopped with damp clay. The plugs were removed with a knife after three or four days, and where no fresh borings appeared it was concluded that the fumes had killed the larvae. Over 95% of the cases thus treated responded satisfactorily.

While carbon bisulphide can be recommended for treatment of single trees, and for use in small parks or along city boulevards, it, necessarily, would be impracticable for control work in extensive forest groves and large areas. Recently, Craighead (1), at Washington, D. C., has found that a lead arsenical.

Some control experiments of this nature were conducted on *P. macmurtrei*, and several materials of different strengths were tried out with various degrees of success. Groups of trees, with their checks, were treated during the summer with solutions of sodium arsenate and lead arsenate, with and without an oil carrier. Carbolic acid, crude petroleum and pyrodene were also employed as ingredients, but were found unsatisfactory for one reason or another. Sodium arsenate proved severe on the foliage, even in small quantities, and was given up for that reason. Lead arsenate in proportion of 3 lbs to 50 galls water without a carrier appeared to have no effect upon the larvae. Even 4 lbs of lead arsenate with a carrier of 1 gal. kerosene emulsion gave only a partial control of 46%; whereas the same spray increased to 5 lbs. resulted in a further 35% of the grubs remaining inactive, making a total of 81% for the last two experiments. Where kerosene emulsion is not obtainable the use of any miscible oil instead will be found ass atisfactory.

Since trees situated in sheltered positions or with a southern exposure appear to be special objects of attack, a careful watch should be kept on such, and where evidences of the borer are noticed, steps taken to eradicate immediately. Very badly infested trees should be cut out and destroyed. This may be done best in the fall or early spring. Such drastic measures, however, are not advisable except as a last resource.

A sharp knife can often be used to good advantage for removing very young larvae from the outer bark. The cut is apt to leave an ugly scar on the trunk if not carefully done; in any case where incisions are made of this kind the wounds should be stopped with grafting wax or painted to prevent infection.

Natural.

Birds.—It is very likely that birds play a most important part in natural control of *P. macmurtrei*. Woodpeckers of different species are seen frequently throughout the summer flying from tree to tree in search of food. It is safe to say that these birds dispose of a large number of young larvae, particularly those of the first year's growth, and since the borers then are not far from the

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(1) Protection from Locust Borer, Prof Paper U S , Dept Agric Bull 787 spray of the usual strengh of 8 lbs to 100 gallons of water has proved beneficia in the control of certain wood-boring species of *Cyllene*, *Goes*, etc The material which is applied with a power-pump, soaks into the bark tissues and incidently about the tunnel entrances When a larva visits the month of the burrow to remove debris, or enlarge the opening for further operations it will eat sufficient of the poisoned bark at the time to kill it The method is a simple and direct one

outer surface of the bark they are readily taken. An inspection of the branches of an infested red oak will convince one of the important role such birds play in the scheme of natural control. Nuthatches, brown creepers, chickadees, warblers and other birds likely destroy many of the eggs. Sometimes the larvae wander over the bark; in this way they expose themselves to the attack of enemies and many no doubt are destroyed.

Parasites.—The only parasite observed was a dipteron which emerged autumn 1922 from a two years old caterpillar taken from a log. Attention was specially called to this larva on account of an abnormal black scar which it was carrying on the dorsum of the thorax. The larva was confined in a tin and died. Shortly afterwards a small gray puparium was found adhering to the tin, close by the withered remains of the host. The specimen was submitted for identifications but on account of its poor condition it could not be determined.

Associated Insects —Ants are often found in and around the tunnels. The large carpenter species, *Camponotus herculaneus* Linn., gets into the heart of the tree by means of the larval burrows and establishes large colonies in the rotting wood, often honey-combing the entire centre of the tree. The carpenter ants bear an interesting commensal relationship with their fellow-workers, the carpenter borers, and while neighbourly do not in any way interfere with the grubs at work, nearby; most likely this is because the ants occupy the discarded burrows and rotted areas, whereas the larvae work in the healthy sound wood.

Injecting carbon bisulphide into infected tunnels will drive the ants out but care should be taken to see that all the holes are plugged before hand, otherwise the fumes will escape and the larvae be left unharmed. Early in June, 1919, one of the trees under observation was badly attacked by borers and ants. There were several large holes at the base through which the ants were working. As soon as the chemical was injected the ants left hurriedly The holes were all plugged, as it was thought at the time, and about two weeks afterwards the trees was cut down. The entire centre was skeletonized into a labyrinth of tunnels. There was no sign of the ants, but the larvae and pupae remained apparently unaffected. An examination showed a number of small holes which had not been stopped, and hence the fumes had escaped, with the above results.

Other arthropods besides ants were found in the tunnels near the entrances, at various times. There were two or three species of centipedes; several species of millipedes; small arachnids, snails, mites, woodlice, and sow-bugs Most of these were attracted, likely by the sapflow, or sought some form of protection within the tunnel's month. Apart from making the observation and securing specimens, nothing worthy of note was recorded of these.

TROPISMS

Mechanical contact.

The larvae are extremely sensitive to touch and will respond immediately to the slightest stimulus, drawing themselves up nervously in jerky movements if interferred with in the least way. Should any of the long erect, hairs on the body be touched or rubbed the larva will assume a defensive attitude rearing itself at once on the prolegs and completely bending back from the first or second abdominal segments so as to bring the head over resting upon the hind part of the body. In this position it will strike back savagely at its aggres-

sor, showing much irritation, at the same time emitting in considerable quantities a dark-coloured liquid of a strong pungent, acetic acid odour. With the ability to move backward quite as readily and swiftly as forward, at the slightest warning of danger it will beat a hasty retreat to the further end of its burrow and remain there motionless. The larva also can reverse its position in the tunnel, if necessary, the largest being able to turn easily within the narrowest confines of its burrow.

Light.

The action of light has a marked effect on both adults and larvae. While the moths would mate and oviposit in the sunshine, they showed an aversion to bright artificial light. Several females confined for egg records at the field laboratory always become much agitated when a light was flashed upon them at night; where previously they were resting quietly, at the approach of the light their wings trembled, antennae and legs moved nervously and a general unrest was exhibited. On removing the light they settled down again.

The very young larvae if in any way exposed to daylight would make every effort to seek cover, persistently shunning the open and hiding beneath their empty shells or any other covering available; in fact the silk webbing always in evidence, was used to form a covering under which the larvae endeavoured to keep themselves sheltered.

Temperature.

Larval activities are influenced by temperature. Certain trees known to have borers working in them were marked in the autumn. The following spring work began before the leaves appeared, and provided the temperature remained about 50°F, the frass would be expelled freely; but if there occurred a drop of 15 or 20 degrees, as frequently happens in late spring, no sign of their work would be found. However, on the rise again of the mercury the boring dust would appear. This response was not immediate, but rather a gradual one.

It was also noticed that the largest number of borings appeared on the warmer sides of the trees, viz; the southeastern, south, and southwestern sides. Isolated oaks, and those more or less in a protected situation, or so located as to receive the sun's rays upon their trunks and branches for the greater part of the day, appeared to be special objects for egg deposition and larval attack.

These preferences would seem to indicate considerable response to thermotropic stimulation by the moth at oviposition and the larvae during boring operations.

Locomotion.

Some simple experiments were tried to determine what effect the surface character of several objects would have on the movement of the moth. It was found that on very smooth material like glass, tin, and polished wood the moth could not walk, even when these were placed horizontally, the legs would be vigorously used but with no result. On paper and on very smooth wood movements were very slow; on coarse or roughened bark progress was normal.

SEASONAL HISTORY.

The moths usually emerge early in June; eggs are laid at once and hatching occurs in 10 days. The first winter is spent in the otter bark, and the second within the inner sapwood. During the third season the larva works in the heartwood, and pupation occurs that fall at the further end of the tunnel. The following June the adults appear. That is to say, larvae hatched, for example in the summer of 1920, will pupate in the fall of 1922 and emerge in the summer of 1923.

SUMMARY

Prionoxystus macmurtrei Guerin-Menville, commonly known as the Lesser Carpenter Worm, is a wood-boring, lepidopterous larva which tunnels in red oak *Quercus rubra*, and 's confined in range chiefly to the eastern parts of Canada and the United States. It will do great damage if allowed to remain and breed for several years in the same stand, large trees being completely ruined by its persistant attacks. Wood-destroying ants and rotting fungi often accompany the borer's injuries. These harmful agencies working within the trunk break down the woody tissus, reduce them to a rotten, honeycombed mass and hasten the destruction of the host. The appearance of sawdust piles or small pellets of frass about the base of an oak forms a safe index to the presence of the borer. Another reliable guide is the swollen canker-like growths appearing on the trunks of the older trees which have been infested for several seasons. These are induced by the tree itself in its endeavour to heal the wounds made by the larvae. Broken down branches and stag-headed trees also supply reliable clues. This form of injury is perhaps the most common and most noticeable.

The female moth resembles in many respects its widely known and more destructive near relative, *P. robiniae*, but may readily be distinguished from it by the numerous black lines which cross the fore wings, *transversely;* whereas the very small male differs considerably from *P. robiniae*, in size outline and colour.

Eggs are laid in June in the crevices of the bark, one female being capable of depositing as many as two hundred and fifty or more. Hatching begins in ten days.

The larvae take three seasons to mature and attain a length of two and a half inches, in the female. They burrow into the outer layers of the bark where they spend their first season. The next year they continue their tunnelling into the sapwood, passing the second winter in a somewhat bent or curved position within the tunnel. During the third year, boring is entirely within the woody parts of the tree and this work is carried on until September when preparations for pupation begin. The transformation takes place in a silk-lined cell at the further end of the tunnel and the moths emerge the next summer early in June. Occasionally, pupation is delayed till the following Spring, and in such a case the emergence will also be later.

Carbon bisulphide injected into the tunnels, which should be plugged at once, is a successful means of control, and may be used to good advantage in small areas. For extensive areas as in large parks, along highways, and forest lands, the following strong arsenical mixture will be found satisfactory:

5 lbs, lead arsenate.
40 galls, water
½ gal. kerosene emulsion or miscible oil.

This should be carefully sprayed into the exit holes and wherever there are indications of larvae working.

Birds, especially those of the woodpecker species, form an important factor in natural control. Their presence in parks and gardens should be more encouraged, and their safety and protection assured by well enforced legislation. Parasites would seem to play little part in natural control.

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A FRUIT WORM (*GRAPTOLITHA LATICINEREA* GROTE) AND ITS CONTROL

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In 1915, *Graptolitha bethunei* G. & R. was present in all the apple orchards of Huntingdon county and damaged as much as 75% of the crop in some orchards. In 1922, the Saddled Prominent (*Heterocampa guttivitta*) defoliated the sugar maples at Franklin Centre over an area of four square miles. In 1923, *Graptolitha laticinerea* defoliated a large number of trees at Cartierville and it was much more destructive on Isle Bizard. Thus almost every year in this

province there are local insect outbreaks by casual pests, which cause very intensive injury.

On June 26th, 1923, along the shore of the Riviere des Prairies the trees were considerably defoliated, and directly opposite on Isle Bizard defoliation was almost complete. The caterpillars were found in numbers on many kinds of trees and shrubs and the presence of injury proved it to be quite a general feeder. The elms, maples and dogwoods were the most seriously injured but apple, soft maple, chestnut and several other trees were injured to a lesser degree. Trees in the open or windswept locations are usually only slightly attacked but in sheltered areas the pest is most important.

The caterpillars were in the last instar and measured from one and one-quarter to one and two-fifths inches in length. The head and mouthparts were light, shiny green, except for the black or brownish tips of the mandibles. The general body colour was apple green and there were dorsal and lateral continuous, broad, white stripes. Tubercles all white and the spiracles surrounded by a black ring. The prolegs and thoracic feet were of the general body colour. The general body colour was sometimes creamy or pinkish, probably the result of the food plant upon which they had been feeding. Several of the larvae were caged and supplied with apple foliage. After a short period they pupated and adults emerged in September. They were submitted to Dr. McDunnough, Entomological Branch, Ottawa, and determined as *Graptolitha laticinerea* Grote. Sanders (1) observed in 1913 that the fifth and sixth stage larvae of *Graptolitha bethunei* G. & R., a closely related species, was predaceous on the pupae of the tent caterpillars (*Malacosoma disstria* and *M. americana*).

The egg is dome-shaped and laid singly on the underside of the tips of the outer branches. Many of the eggs are deposited at the base of the buds or on bud scales and when in the latter position they often drop to the ground before the larva emerges. Pupation takes place during July from two to four inches below the surface. The pupa is naked, yellowish-brown and three-quarters of an inch in length. The adult is a dull coloured, grayish moth, with inconspicious markings and one and one-quarter inches wide, when the wings are expanded. They are strong fliers and are on the wing for a month in the fall and another month in the spring. According to Slingerland (2) they are, "often found in maple groves while sugaring is going on. Sometimes sap pails are found in the morning, completely covered with moths."

Remedies,

According to Slingerland and Crosby (3) they should receive the following treatment. As the green fruit worms are about half grown when they begin feeding on the fruit it is then a very difficult matter to kill them with a poison spray. Earlier when feeding on the buds and newly opened leaves many of the

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1.—Sanders & Dustan, Dom. Can., ept. Agr. ,Ento,m Bul. 17, p. 13.
2.—Sanders & Dustan. L.C. ρ. 8.
3.—Slingerland & Crosby, Manual of Fruit Insects,p. 41.

young worms could doubtless be destroyed by a thorough application of arsenate of lead, 2½ or 3 lbs. in 40 gals. of water or dilute lime sulphur solution.

Sanders and Dustan (1) offer the following advice. The height of emergence takes place when the blossoms are showing pink. Therefore, in serious outbreaks the spray should be applied just before the blossoming period. The calyx spray is also important and in both applications high velocity, drenching sprays should be applied. Arsenate of lead 5 lbs. to 40 gals. of water or dilute lime sulphur solution is the most satisfactory mixture.

According to Sanders and Dustan, (2) "The most important natural means of control are wind and rain which cause immense numbers of the larvae to drop to the ground and perish during the first two weeks of their existence".

THE STRIPE OR STREAK DISEASE OF TOMATOES IN QUEBEC.

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Introduction.

Early in the spring of 1923 the tomato crop in the commercial greenhouses at Macdonald College became infested with a disease which was characterised by a long spindling growth of the upper part of the plants, a spotting, curling and shrivelling of the leaves, small irregular brown spots on the fruit, and brown, oblong, sunken markings on the stem and petioles.

On examining the literature it was found that the disease resembled most closely one which has been reported on under a variety of names, and concerning which investigators differ in their opinion as to the etiology.

Previous Investigations.

The first account of such a disease was given by Bailey (1), in 1892, when he reported a blight of winter tomatoes which corresponds in many details with the outbreak here in Quebec, except that he found no spotting on the fruit. To this he ascribes the name "Winter Blight of Tomatoes". He was unable to determine the specific cause of the malady.

Five years later Selby (2), from Ohio, described a blight of forced tomatoes with symptoms similar to those described by Bailey, but he reports a spotting on the fruit. He was unable to find any organism associated with the diseased tissue; whereas Bailey mentions that a micrococcus was found in the diseased parts.

In 1916, the disease was first reported from Canada by Howitt and Stone (4). Repeated trials to isolate a causal organism from the diseased tissues

1.—Sanders & Dustan, Loc. cit. p. 15.
2.—Sanders and Dustan, Loc. Cit. p. 16.

proved futile. From carefully conducted experiments these investigators suggest that the cause of the trouble lies in the soil.

C. R. Orton has also reported the disease from Pennsylvania.

In 1919, Paine and Bewley (5) reported a disease of tomatoes, with apparently identical symptoms with those described above, as being present in England and the Channel Islands. These investigators were able to isolate a bacillus, which they later identified as *Bacillus lathyri*, from diseased tissue, and with it they could bring about artificial infection.

Schroevers in 1922, mentions stripe disease of tomatoes as occuring in Holland, and Taylor in 1923, reports it from New Zealand.

Gardner and Kendrick (6) in an article on tomato mosaic published in 1922 from Indiana, are of the opinion that the diseases described by Bailey of Cornell and Selby of Ohio, as well as those reported from Pennsylvania and Ontario, are mosaic in its most destructive from. They state that "it seems very likely that many of the puzzling greenhouse tomato diseases or winter blights reported in literature were merely different manifestations of mosaic."

B. T. Dickson reported it from Macdonald College in 1923, this being the first time that the disease was reported from the Province of Quebec. Professor Dickson inclines to the view that it is a mosaic in which Necrosis occurs under certain environmental conditions.

Since there is still some doubt as to the actual cause of this so-called stripe or streak disease of tomatoes, it was decided to investigate the problem, and Mr. J. K. Richardson, M. Sc. began a study of the disease in 1923 under Quebec conditions. The disease was carried over the summer of 1923 on tomato plants in the field. Healthy plants were inoculated by rubbing their leaves with crushed leaves and petioles of diseased plants.

In the early spring of 1924, at the suggestion of Dr. Dickson, the writer undertook to carry on the investigations in the experimental greenhouses and plots at Macdonald College.

It was thought advisable to make a progress report at this meeting of the Quebec Society for the Protection of Plants, especially as it is the first time that work is being done on the disease in this province.

Symptoms of the Disease.

An attempt to describe in detail a set of clear-cut symptoms of the stripe disease of tomato, would necessarily be inadequate because of the various forms which the disease takes depending apparently upon the succulence and age of the plant, as well as upon the temperature, illumination, etc. Therefore the general symptoms will be given with here and there variations from the general type which are often quite characteristic.

At Stage of Infection.

Ordinarily the disease is first noticed on the tomato plants about the time the first blossom truss appears, and necrotic streaks occur in a zone about a

foot in extent two-thirds up the plant. Here the leaves begin to show irregular yellow spots which subsequently turn brown and finally quite dark, being still surrounded by yellowish areas. Later complete necrosis with wilt and drying out occurs.

The upper growth becomes spindling and distorted, (Plate II) the leaves small and weak with numerous yellowed and minute necrotic areas. As one looks down the rows between the greenhouse tomato beds the spindling growth of the upper part of the plants is very prominent. Infected plants usually linger on in this condition for several weeks, but rarely there is complete wilting of the whole plant — following on curling and shrivelling up of the leaves.

Immediately below the diseased zone there are on the average eight to ten strong, healthy lower leaves. These seldom show lesions, but the shoots which may arise from the exils of these leaves show typical symptoms.

The necrotic areas on the leaves do not usually conform to any definite arrangement, but any one of the three following types may be observed: First, the speckling may fellow the veins more or less; secondly, the specks may be grouped together — many having coalesced — on both sides of the main vein at the end of the leaf nearest the stem, or thirdly, the specks may be grouped together on both sides of the main vein and extending to the edges and tip of the leaf.

In the diseased zone, brown, sunken, oblong stripes or splashes are found on the stems (Fig. 1) petioles, flower stalks and calyces. These streaks occur simultaneously with the specks on the leaf laminas, as a rule.

No yellow streaking has been observed on the stems, as is the case with the leaves, but the lesions appear brown from the first. These are linear, varying in size from one millimeter to several centimeters in length; they enlarge and often coalesce, although this last is a very variable condition. The larger lesions on the petioles have a more water-soaked and sunken appearance than those on the stem. They gradually enlarge, eventually causing the petiole to shrivel, turn brown, and dry out backwards with the leaflets hanging dry and dead.

The lesions on the sepals are relatively small and not elongated.

On the fruit are found dark brown, shiny, sunken, irregularly shaped patches, with no definite arrangement. (Fig. 2) In the initiation stage these appear to be greenish brown, but both types occur on the fruit at the same time. They may occur anywhere on the fruit, although in one type they seem to be confined to the stem end. The largest of the patches, produced by coalescence of the smaller ones, frequently possess one or more cracks or slits produced by drying out. Severely affected fruit tend to be deformed.

An examination of the roots both externally and internally reveals no apparent divergence from the roots of a normal plant, except that perhaps the root system is somewhat reduced.

Frequently plants are found which show a superficial bronzing on the leaves in the necrotic zone. On examining these either with a pocket lense or

Fig. 1.—Stripe lesions on stem of tomato from south house (Fig. 3).

Fig. 2.—Characteristic lesions on fruit.

PLATE II

Type of growth of a diseased plant. A to B healthy, B to C zone showiug stripe lesions in stem, petioles (1) and leaves with leaves shrivelling and dying later (2), C to top-straggly, spindling and weak stem, deformed leaves with symptoms of mosaic and occasional stripe lesions.

under the microscope, it is found that the multicellular ends of the glandular hairs are all dark brown. Furthermore, these structures are considerably more numerous on diseased than on healthy plants, on which last the trichomes are green in colour.

One observation worthy of note is that all the tomato plants here at Macdonald College infested with stripe also had mosaic. In many cases the mosaic symptoms were not clearly apparent at first; but the characteristic symptoms always developed later, the light green and dark green patches being distinctly clear cut.

Some Internal Symptoms.

(*1*) *The stem.*—Cross sections of diseases stems show that usually the brown lesions are only superficial, but in some, the necrosis extends well into the cortex, and in others again, the pith is invaded as well. The vascular elements do not show any definite symptoms of necrosis. Longitudinal sections taken at the junction of the petiole with the stem show that the necrotic tissue leads from the one into the other, either by the cortex, or by the pith or by both. Small brown patches are also found in the pith and cortex.

(*2*) *The petiole.*—Internal symptoms are similar to those of the stem; but the extent of the internal browning ranges from lesions including the epidermis and a few layers of cells of the cortical tissue to cases where the whole petiole is necrotic — all the tissues being affected. The course of the brown area can be traced from the cortex into the pith, the vascular elements being unaffected in the majority of cases.

(*3*) *The leaves.*—All the tissues of the leaf except the vascular bundles become necrotic. There is a shrivelling and drying up of the lamina in affected areas and here the walls are quite brown. The cells in such areas and those closely adjoining appear to be completely collapsed and desiccated. Such tissue stains very deeply with Gentian Violet and Carbol Fuchsin. It cannot be definitely stated that bacteria are or are not present; for, on the borders of some lesions short rods which have taken the stain deeper than the surrounding material, are observed in small numbers. If they are bacteria, they are far fewer in number than is commonly the case in plants attacked by bacteria and they may be secondary in the lesions.

Enlarged nuclei are often found in cells adjoining necrotic lesions. Affected leaves are found to possess an abnormal number of cells containing shining crystalline deposits which will not stain.

(*4*) *The fruit.*—The spots on the fruit are usually superficial and include only a few layers of cells. Occasionally brown streaks and patches of tissue are noticed interspersed here and there within the fruit.

(*5*) *The roots.*—The roots from twelve severely diseased plants were examined by cutting longitudinally and transversely but no indications of the presence of bacteria were observed in any case.

Paine and Bewley (5) on the contrary found organisms in the roots and consider that infection is possible from the root up into the plant.

Distribution of Stripe in Greenhouse.

From a study of the South House, (Fig. 3), it is clearly seen that the outer rows in each bed where the disease occur are much more heavily infested than the inner rows. In a conversation with Mr William A. Ross, Entomologist-in-charge at the Vineland Station, Ontario, he remarked that he had observed a similar distribution of the disease in greenhouses near London, Ontario. In the North House where there were only a few diseased plants when the count was taken, these occured on the outside rows only; the two rows on the inside in every case being entirely free from the disease. A count of the south house shows that of 213 diseased plants, 135 were on outside rows and 78 on inside.

From the foregoing it might be inferred that the disease is probably transmitted by the greenhouse attendant both when watering the plants, disbudding or pollinating them. Incidentally, it might be mentioned that the tomato crop in the two houses shown above was a complete failure.

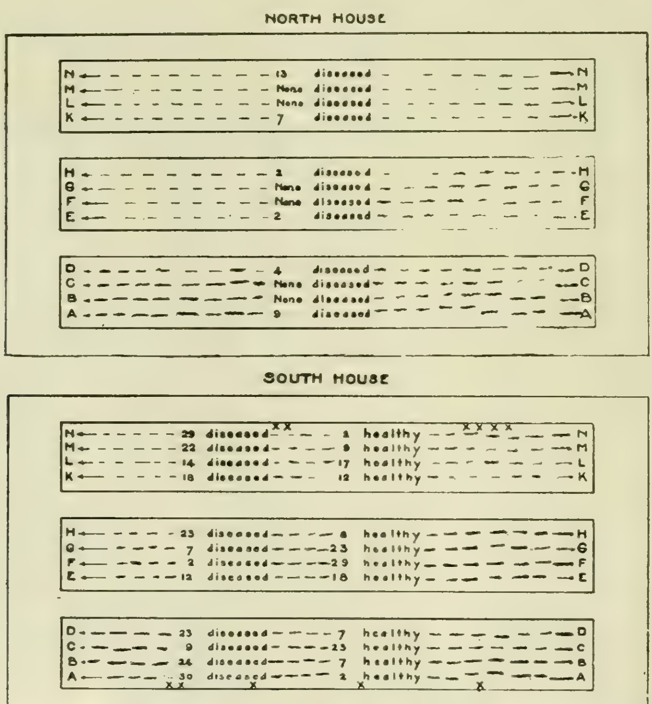

Fig. 3.—Plan of green houses showing distribution of stripe disease of tomatoes. First plants at X on March 12. Count taken April 5, 1923.

Experimental Work To Date.

Isolations.—Numerous attempts to isolate a causal organism from diseased tissue were made, and in a few cases — the majority being from internal stem lesions — a yellow motile organism was obtained. This was cultured on nutrient and potato agars and in beef bouillon, and the following preliminary inoculation experiments made:

Series 1.—The organism was inserted, under sterile conditions as far as possible, in a slit in the stem of healthy tomato, potato, tobacco, sweet pea and broad bean plants; the stem carefully wrapped with tin foil, and the plants placed under large bell jars. This experiment was duplicated, and cultures of a yellow organism isolated at different times were also used, but in every case the results were negative.

Series 2.—The organism was sprayed on healthy tomato, potato, tobacco, sweet pea and broad bean plants, both wounded and unwounded; and as before no disease symptoms were produced.

Series 3.—The series of experiments tabulated below were carried out by Dr Dickson in 1923;

Plant.	Inoculum used	Date of Inoculation	Appearance of first lesions.	Incubation period.
1. Tomato.	Crushed leaflet rubbed.	March 24th.	April 3rd.	10 days.
2. Tomato.	Cortex inserted.	April 6th.	April 16th.	10 days.
3. Tomato.	Yellow organism rubbed.	April 6th.	April 16th.	10 days.
4. Tomato.	Yellow organism rubbed.	April 6th.	April 16th.	10 days.
5. Tomato.	Scraping inserted.	April 6th.	April 16th.	10 days
6. Tomato.	Insertion.	April 7th.	April 19th.	12 days.
7. Tomato.	Insertion.	April 10th.	April 18th.	8 days.
8. Tomato.	Scraping inserted.	April 11th.	April 30th.	19 days.
9. Tomato.	Pith inserted.	April 28th.	May 9th.	11 days.
10. Tomato.	Pith inserted.	April 28th.	May 9th.	11 days.

From a study of the table, it is interesting to note that, with the exception of plant No. 8, the time between inoculation and the first appearance of symptoms, is about 10 days. In this connection it might be noted that this is the time taken for tomato mosaic to develop. Also, that the organism used on plants Nos. 3 and 4 was an original culture from necrotic tissue implanted on a nutrient agar slope. First and subsequent subcultures of the yellow organism from this tube failed to produce the disease on healthy tomato plants later.

Series 4.—In April 1924, the writer inserted diseased tomato tissue into healthy plants of potato, sweet pea and broad bean and covered the wound with tin foil. No positive results were obtained.

In continuing experiments in the greenhouse this winter it was found that the easiest way to transmit the disease was by rubbing the leaves of healthy plants with crushed tissue of diseased plants.

Series 5.—The two sets of experiments outlined below demonstrate the difference in the length of incubation period depending apparently on the temperature. Although one set of experiments were conducted in the field and the other in the greenhouse, I think that they are nevertheless comparative inasmuch as the inoculations were made at blossoming time — when the plants were in as near the same conditions physiologically as the differences in environment would permit. There is, of course, the possibility of a difference in virulence or in amount of inoculum.

Experiment 1.—By Dr. Dickson: Four plants in the field were inoculated by rubbing with diseased tissue from greenhouse plants on July 20th, 1 23. On August 1st, lesions appeared in young leaves, petioles and stems. That is, there was an incubation period of 11 days.

Experiment 2.—In an experiment conducted by the writer, four plants in the greenhouse were inoculated by rubbing with diseased tissue on February 22nd, 1924. The greenhouse was kept at a temperature of 48–50°F.

Results: One plant showed first symptoms of streaking on stems and petioles and specking on the young leaves 18 days after inoculation. Plant 2, showed first symptoms 22 days after inoculation; plant 3, 25 days after, and plant 4, 27 days after. Checks remained healthy.

From these experiments it might be inferred that a temperature as low as 50°F lengthens the incubation period as compared with summer temperature.

Series 6.—When healthy tobacco plants are inoculated by rubbing with striped tomato plants, only mosaic symptoms are produced; that is, no specks or splashes develop. In this connection the following experiments are of interest.

1. A healthy tomato plant was inoculated by rubbing with crushed leaves of a tobacco plant having mosaic. This plant contracted the stripe disease, the lesions being very small, however.

2. Stripe disease was also produced on tomatoes in the greenhouse rubbing with mosaic tissue from Resistant White Burley tobacco. It must, however, be noted that the tomato plants in both experiments were uncovered, so that the possibility of transmission of the disease from one of the other diseased plants in the same field or greenhouse, was possible. Therefore, a repetition of this experiment under controlled conditions is necessary. This is being carried out at the present time.

It is interesting to note that Clinton (3), in 1907, performed the following experiment amongst others :—

"Exp. 28. Nov. 11, tomato plant was crushed after crushing fresh leaves of calicoed tobacco in hands. Nov. 25, young leaves and stem showed elongated, irregular, discoloured streaks or burns, like a bacterial disease, but no true calico-like appearance. Check plants showed no similar trouble. Jan. 8, plant dead of wilt, but before dying, some leaves showed signs of true calico. The bacterial-like burn of the leaves, however, was the conspicuous trouble."

As has been previously stated this is a progress report and further experiments in the field on tomato, potato, tobacco and other Solanaceous plants are being carried out on a large scale this summer.

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CULTURAL CHARACTERISTICS OF CERTAIN COLLETOTRICHUM SPECIES.

by

G. A. SCOTT, B.S.A., M. Sc.

Introduction.

Among the fungi, one of the most important groups is that which includes the "anthracnose organisms", that is to say, the Colletotrichums and Gloeosporiums, the Volutellas and Vermicularias with the perfect stages of such of these as are known. As a group it has received considerable attention from the point of view of Morphology, Cytology, Physiology, Taxonomy, Pathogenicity, etc.

The study reported here was suggested by Dr. B. T. Dickson, Head of the Department of Botany, Macdonald College of McGill University and was undertaken by the writer while holding a Macdonald Scholarship for 1923-24.

During the last few years attention has been drawn to diseases of potatoes variously known as "Dartrose", "Black Dot", "Foot Rot", "Anthracnose", etc. The diseases have been described from France, England, Canada and the United States of America. From published descriptions there appeared to be sufficient similarity in symptoms to warrant a study of the causal organisms in order to determine their relationship. The present paper is concerned with the cultural characteristics of the organisms on various media, and, at the same time with certain morphological characteristics which were considered of sufficient importance to form the basis of comparison.

Historical Review.

In 1908 Ducomet published an account of a new potato disease occuring in France which he called "Dartrose". This he ascribed to *Vermicularia varians* sp., nov., which organism he stated was an "Espece variable, évoluant vers les Phoma ou inversement vers les Colletotrichum et Gloeosporium".

O'Gara in 1915 reported a new species of Colletotrichum on potato which he found in the Salt Lake Valley, Utah. He considers it related to Vermicularia and named it *Colletotrichum solanicolum.*

Taubenhaus in 1916 in his studies of silver scurf of potato described a Colletotrichum which he regards as identical with O'Gara's organism but which on a basis of priority he calls *Colletotrichum atramentarium.*

Pethybridge reported a similar disease from Ireland in 1918 and in studying the organism came to the conclusion that it should be called *Colletotrichum tabificum.*

Dickson in 1921 found a black dot disease to be quite common in Quebec and the organism concerned appeared to be identical with that described by Ducomet except that no pycnidia were ever found.

Organisms used.

In this study the following organisms were used.

1. The isolation from Canadian material herein called the *Quebec organism.*
2. The saltation from No. 1. (see Dickson '23), herein called the *Saltation.*
3. *Vermicularia varians.* Ducomet.
4. *Colletotrichum tabificum.* (Hallier p. p.) Pethybridge.
5. *Colletotrichum atramentarium.* (O'Gara) Taubenhaus.
6. *Colletotrichum atrovirens.* (?).

Source of the cultures.

All the above cultures were turned over to the writer by Dr. Dickson who states that he obtained them as follows:

1. *Quebec organism.*
   Culture made by Dr. Dickson from Quebec material.

2. *Saltation.*
   Culture made by Dr. Dickson from *Quebec organism.*

3. *Vermicularia varians.*
   Subculture made from a culture of Dr. Pethybridge made in turn from one by M. Cavadas from French material.

4. *Colletotrichum tabificum.*
   Culture made by Dr. Dickson from potato material sent by Dr. Pethybridge.

5. *Colletotrichum atramentarium.*
   Subculture made from a culture sent to Dr. Dickson and made from Ohio material by Dr. Freda Detmers.

6. *Colletotrichum atrovirens.*
   Culture sent by Dr. N. J. Giddings of the Laboratory of Plant Pathology of the West Virginia Agricultural Experiment Station at Morgantown, W. Va. The writer has not been able to find any published technical description of this organism.

Media used.

Since one ot the main objects of this investigation has been a carefull study of the cultural variations of the above organism, as large and as varied a number of media as time warranted were used. The media falls, naturally, into two classes *solid* and *liquid.* The first class consists for the most p art of plant media and nutrient media made with agar. In the second group is a number of well-known nutrient solutions.

Cultures were grown in tubes of different sizes, in 150 cc. Pyrex Erlenmeyer flasks and in petri dishes. All glassware was thoroughly washed in tap water, rinsed in distilled water and autoclaved for twenty minutes at fifteen pounds pressure before it was used. This method proved satisfactory and very little contamination resulted.

Of the solid and liquid media used the following were found to be the most suitable:—

Solid
1. Potato-dextrose agar.
2. Czapek's synthetic agar.
3. Oatmeal agar.
4. Cornmeal agar.

Liquid
1. Currie's solution.
2. Pfeffer's solution.
3. Czapek's synthetic solution.
4. Duggar's synthetic solution.

"Merck" chemicals were used entirely in the preparations of the liquid media.

Observation on type and rate of growth.

On solid media.

On the solid media used growth characteristics were so similar that the writer will not give individual descriptions. With the exception of the *Saltation,* the general type of growth was as follows :

The first indication on the medium was the production of a white downy to downy silky, superficial mycelium. No coloration was observed until about the end of the fourth day when a distinct amethyst color, most prominent in the centre of the culture, began to appear. This amethyst coloration is a striking general characteristic of all the cultures. In a few plates a yellow coloration was also noted. At the end of the sixth day black sclerotia appeared on the surface of the agar and the white superficial mycelial growth began to disappear. The sclerotia are almost invariably produced in concentric rings in petri dish cultu-

res. Contrary to the findings of Ducomet ('08), pycnidia were not found in any of the cultures. On Czapek's and cornmeal the sclerotia are more distinct than on potato-dextrose or oatmeal. On the latter two, the sclerotia are massed together and do not appear individually to such an extent. On cornmeal there is sometimes a distance of an eighth of an inch between two sclerotia. On old cultures where a large number of conidia have been produced, the surface layer will again be covered by a superficial layer of white mycelium, produced no doubt by the germination of the conidia.

In the case of the *Saltation* no sclerotia were developed at all. The amethyst color was discernible in all the cultures but the predominating color was yellow. Conidia were produced very luxuriantly in all cultures. On close examination it appeared that each conidiophore always bears a conidium at its tip and others are found lower down. After the first falls others are developed in the same place.

The results of microscopic examinations of conidia are given in the following table;

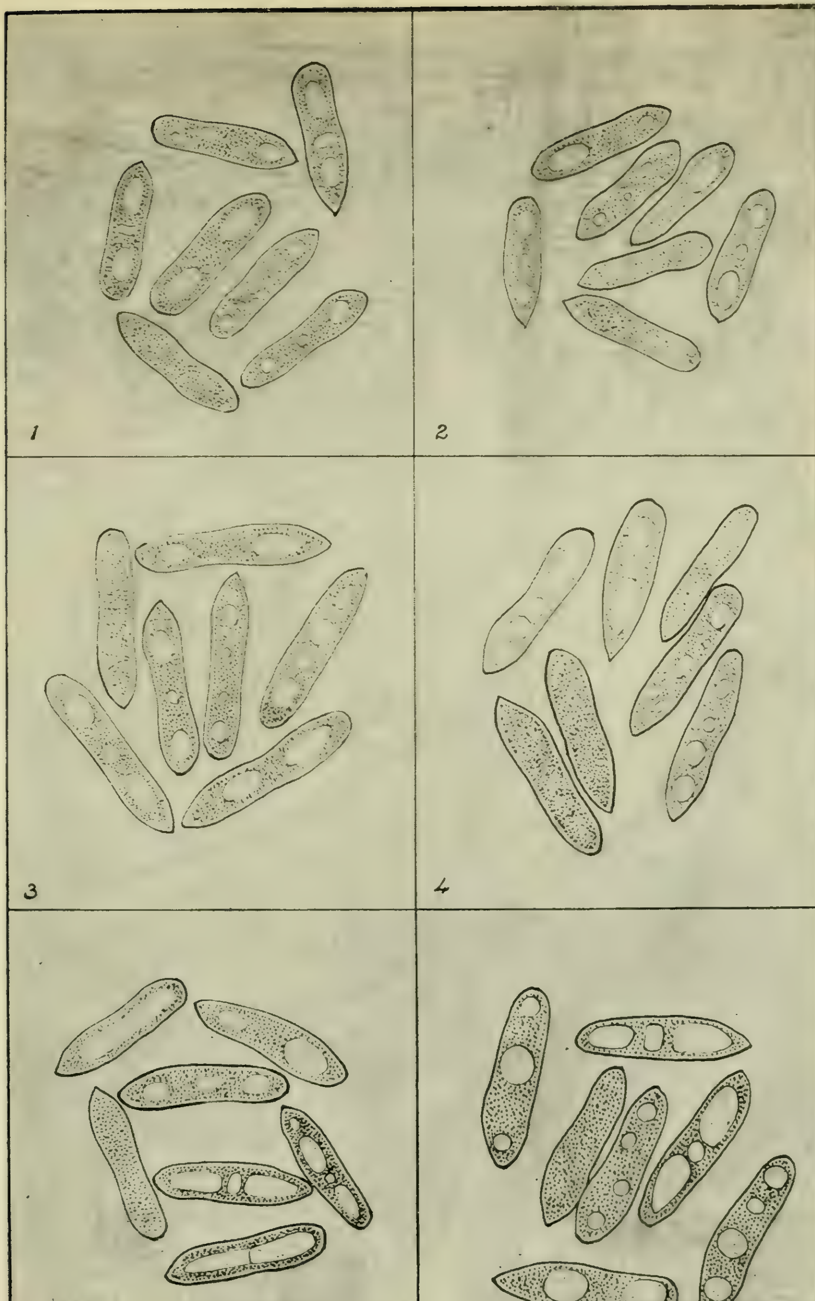
Spores.

Org.	Lenght.	Width.	Color in mass.	Guttulation.
Que. org.	17.8 – 20.7u	3.0 – 3.7u	pink.	1 – 3.
Saltation.	17.5 – 19.7u	3.0 – 3.8u	yellow.	1 – 3.
V. varians.	18.0 – 20.6u	3.5 – 3.7u	pink.	1 – 3.
C tabif.	19.1 – 20.8u	3.0 – 3.7u	pink.	1 – 3.
C. atram.	17.5 - 19.6u	5.0 —3.9u	pink.	1 – 3.
C. atrov.	16.5 – 18.8u	5.4 – 5.7u	pink.	1 – 3.

The spores vary in size to an appreciable extent. The above measurements are the average of a large number of determinations. In shape they are identical being continuous, cylindrical, slightly pointed at the basal end and rounded at the apical end. Some are slightly curved and restricted at the middle. The number of guttules varies from 1–3. In a few conidia there are 4 guttules but that is an exception. The presence or absence of guttules seems to be governed by the factors of age and nutrition.

The mycelium is septate in all cases. The cells vary in size to a marked extent. The vegetative cells are cylindrical in shape while the sclerotial cells are more or less rounded to barrel shaped.

As stated above, sclerotia appeared in all cultures with the exception of the *Saltation*. They were oval to round in shape, black in color, and varied in size from a very minute mass of black mycelium to a well defined body that could easily be distinguished with the naked eye. The term sclerotium is here used to include the small black mass of mycelium with or without setae.

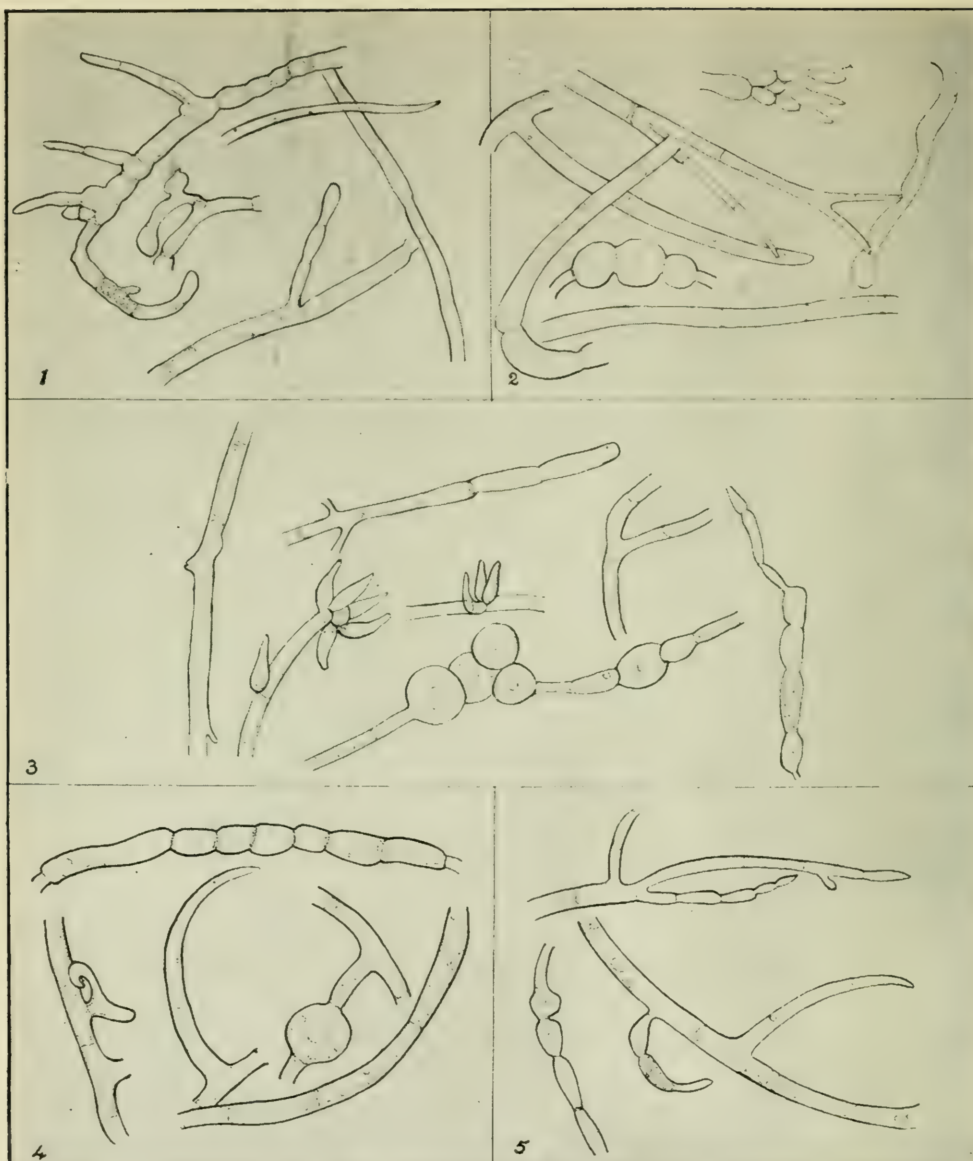


Scale. 1″ to 20 microns.

Camera lucida drawings of spores of the six organisms on potato-dextrose agar, 21 days at 20o C.

1. Colletotrichum tabificum.
2. Saltation.
3. Vermicularia varians.
4. Quebec organism.
5. Colletotrichum atrovirens.
6. Colletotrichum atramentarium.

PLATE II



Scale. 1/10″ to 3 microns.

Camera lucida drawings of mycelium, on corn meal agar, 21 days at 20o C.

1. Colletotrichum tabificum.
2. Saltation.
3. Quebec organism.
4. Cotlelotrichum atramentarium.
5. Colletotrichum atrovirens.

Setae were observed to arise from the sclerotia of all the organisms at some time or another. In the case of the *Quebec organism* and *Vermicularia varians* setae were found present in all the cultures while in the case of *Colletotrichum tabicfium*, *Colletotrichum atramentarium* and *Colletotrichum atrovirens* setae were not present at all times and when present were fewer and much shorter. The last two organisms named have been cultured on artificial media for a much longer time than the others and the writer attributed the non appearance of setae to this fact. The setae arising from the sclerotia of the *Quebec organism* and *Vermicularia varians* varied in length from 80 - 120u; the width near the base was from 2–2.6u, and tapered to a fine point. The oldest setae are usually 2–4 septate, black in color and arise from the centre of the sclerotium. When young, they are light colored towards the tip.

Spores of the six organisms were germinated in tap water in hanging drops. Germination was similar in each case. Each spore produced a single germ tube. Germination was typically acroblastic, but in cases where it was pleuroblastic the germ tube originated nearer the apical end.

On Liquid Media.

The organisms under observation grew well on suitable liquid media, but the chracteristics discussed above were, on the whole, very much slower in development, and did not prove as striking in appearance as those displayed on the solid substrata.

On liquid media, the same similarity in type of growth was observed, the *Saltation* being the only one that could be differentiated from the others on any of the media used. It could be picked out by the fact that only white submerged mycelium developed and no sclerotia appeared. There were three main stages in the growth of all cultures; first, the formation of white submerged mycelium, second, the formation of a surface layer of mycelium and third, the appearance of sclerotia on the surface layer. After the formation of the surface layer the pink coloration (described later) was evident before the black sclerotia were formed. No growth resulted in flasks containing Knop's solution, and from this fact it would appear that sugar is essential to growth.

Rate of growth.

The following experimental work was carried on to determine and compare the rate of growth on solid media of the five organisms. *Vermicularia varians* has been omitted from this study as a culture of it was not available at the time the work was done.

The methods adopted were as follows:

1. Petri dishes of uniform size (90 mm. in diameter and 14 mm. in depth) were chosen and sterilized in a hot air oven in the usual manner.

2. Four different solid media were chosen, potato-dextrose agar, Czapek's, cornmeal agar and oatmeal agar. Fifteen cc's of the media were poured into each dish and allowed to solidify.

3. Approximately two weeks before the starting of each series of experiments, cultures of each fungus were started, by transferring small bits of medium containing mycelium from a stock culture to the centre of potato-dextrose agar plates. These plates were used as the source of inoculum for the *experimental* cultures. Little plugs or disks, 5 mm. in diameter and about 2 mm. in thickness were cut by means of a sterile cylindrical tube. Each disk was lifted on the flattened end of a platinum needle and was then inverted and placed centrally upon the surface of a new plate. As the mycelium grew out in every direction from the centre of the plate a rounded mat was formed. The disk remained practically circular as it enlarged, forming nearly a perfect circle at all stages of enlargement.

4. Measurements were made at daily intervals for a culture period of ten days. A thin millimeter rule, applied on the bottom of the petri dish outside, was used for measuring the diameter of the growth. Measurements with the millimeter rule were read to within 1 mm. This was thought to be sufficiently precise for the purpose.

5. All the cultures were grown under exactly the same conditions as to depth of medium, moisture, temperature and light.

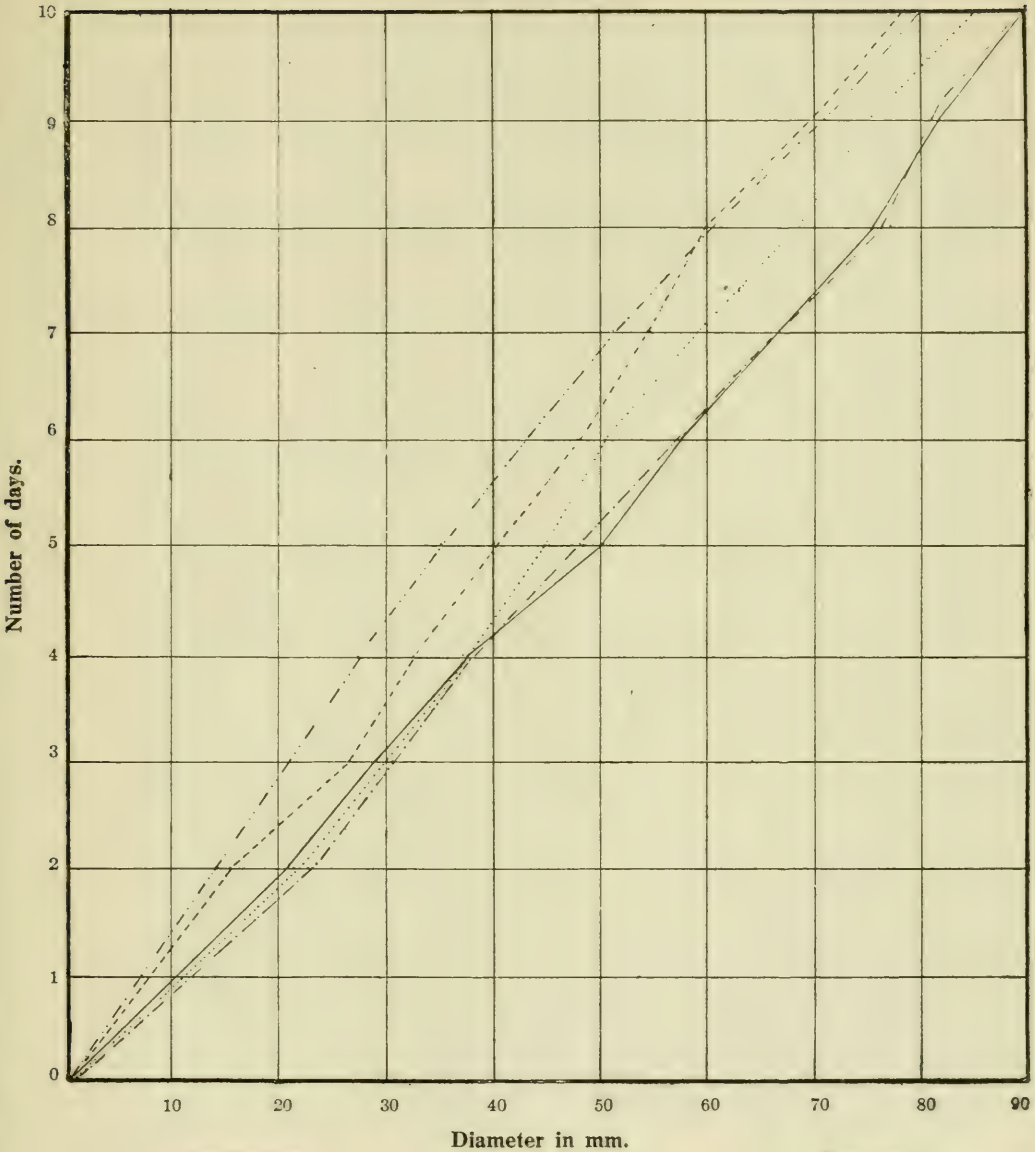
6. In any case where the mycelial disk in the petri did not form an exact circle, the diameter was measured in several places and the average taken.

The following table and graph show the results:

Diameter in mm. at the end of 10 days.

Organism.	Potato.	Czapek's.	Cornmeal.	Oatmeal.
Que. org.	88	63	67	72
Saltation.	80	64	60	74
C. tabif.	78	68	70	69
C. atram.	85	67	73	79
C. atrov.	90	73	71	80

Potato-dextrose agar.



——————— Quebec org.

—. .—. .— Saltation.

- - - - - - - C. tabif.

. . . . C. atram.

—.—.—. C. atrov.

The preceding table and graph show that :

1. The rate of growth for the five organisms is very similar.

2. Of the four solid media tried, potato-dextrose agar was the best for growth; oatmeal agar was second while cornmeal and Czapek's were almost equal.

3. There is a marked regularity in rate of growth in each case as indicated by t he graph.

The following experiments were conducted with three objects in view :—

1. To determine the proportions to obtain the best growth.
2. To study the type and amount of growth.
3. To ascertain the relationship between growth and H–ion concentration.

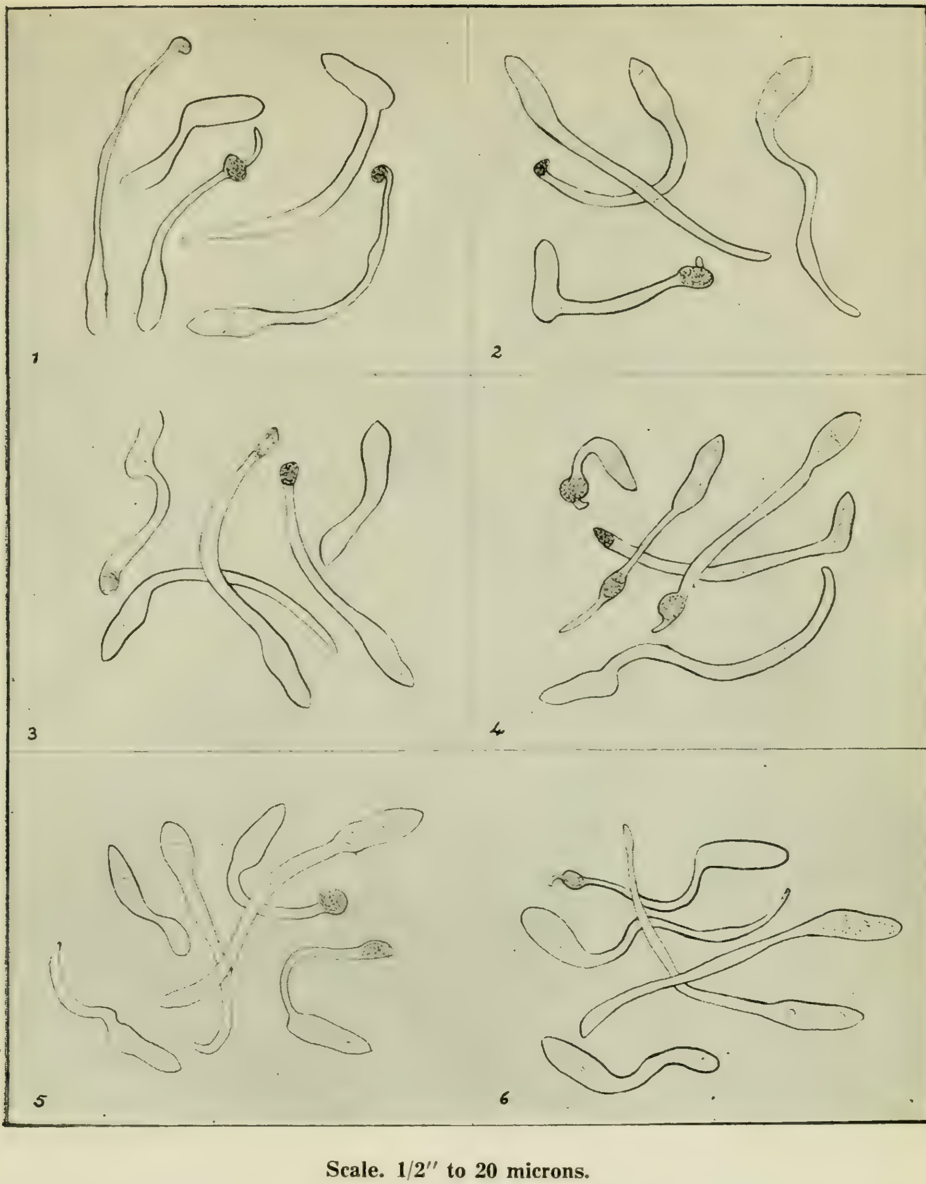
From the previous culture solutions it will be noted that a number of inorganic elements have been used. We have, however, no evidence to the effect that these inorganic elements have been used in the correct proportions. Since the salt requirements for fungi are probably the same as for higher plants, a series of culture solutions was arranged according to the method used by Young and Bennett ('22) in their studies of fungi in culture media. A series of twenty-one cultures, using potassium acid phosphate (monobasic), calcium nitrate, and magnesium sulphate was set up. The salts varied in the different solutions by increments of one-eighth and had an osmotic concentration of three and one-half atmospheres. Sucrose was added in equal amounts of 3.42 grams per 100 cc. of the culture, thereby giving the culture solution a total osmotic concentration of four and one-half atmospheres.

In these triangles the individual cultures are numbered according to the row in which they occur and according to their position in the row. The rows are numbered from the base to the apex of the triangle. The position in the row is from left to right. Thus the culture on the extreme left of the first row is numbered 11, the second from the left in the third row is 32, and in this way every culture flask receives a number.

The method of arranging the concentrations is given in the following table :—

Flask no.	Cc. of M/14 KH_2PO_4	Cc. of M/14 $Ca(NO_3)_2$	Cc. of M/14 $MgSO_4$	Cc. of Sugar sol. 3.42g. in 10cc.	Water to make sol. to 50 cc.
11	4.0	4.0	22.4	5	14.6
12	3.5	6.8	17.2	5	17.5
13	3.4	10.0	13.2	5	18.4
14	3.1	12.4	9.4	5	20.1
15	3.1	15.0	6.0	5	20.9
16	3.0	17.0	2.8	5	22.2
21	7.4	4.0	17.2	5	16.4
22	7.0	6.8	15.2	5	18.0
23	6.5	10.0	9.4	5	19.6
24	6.2	12.4	6.0	5	20.4
25	6.0	15.0	2.8	5	21.2
31	10.6	4.0	13.2	5	17.2
32	10.0	6.8	9.4	5	18.8
33	9.5	10.0	6.0	5	19.5
34	9.0	12.4	2.8	5	20.8
41	13.8	4.0	9.4	5	17.8
42	13.2	6.8	6.0	5	19.0
43	12.6	10.0	2.8	5	19.6
51	17.2	4.0	6.0	5	17.8
52	16.4	6.8	2.8	5	19.0
61	20.3	4.0	2.8	5	17.9

Special care was taken in the inoculation of solutions so as to obtain uniform growths at the outset. A modification of Hasselbring's ('06) method of



Scale. 1/2″ to 20 microns.

Spores germinating in tap water, 36 hours at room temperature.

1. Colletotrichum tabificum.
2. Saltation.
3. Vermicularia varians.
4. Quebec organism.
5. Colletotrichum atramentarium.
6. Colletotrichum atrovirens.

PLATE IV.

Fig. 1. Fig. 2. Fig. 3.

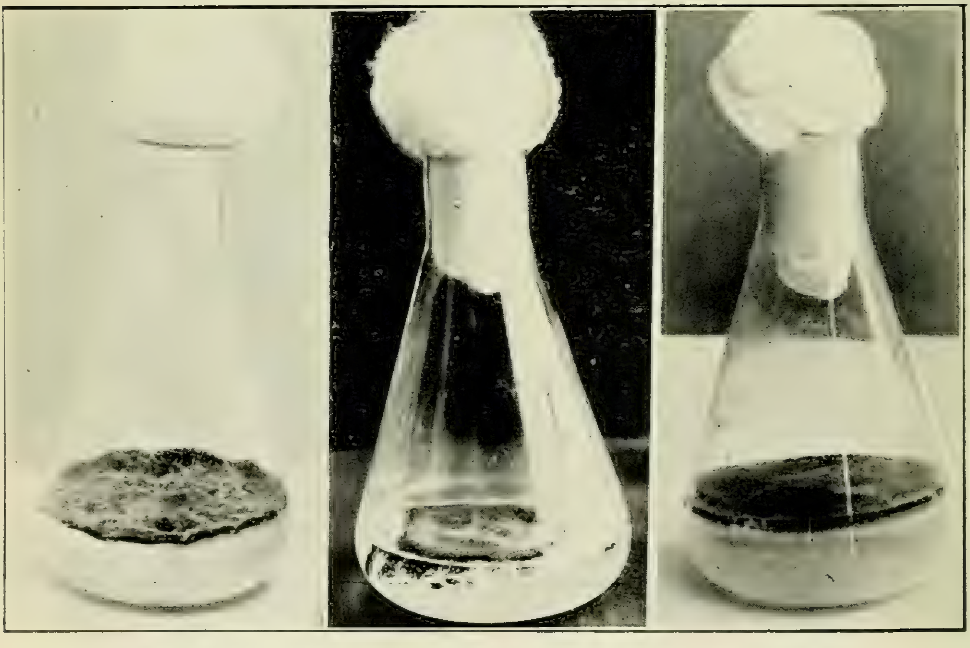


Fig. 4. Fig. 5. Fig. 6.

Growth in flask 61 (apex of triangle) 16 days at 21o C. Solutions composed of :

M,14 KH2PO4	—	20.3 c.c.
M,14 Ca (No 3) 2	—	4.0 c.c.
M,14 Mg SO 4	—	2.8 c.c.
Sugar (3.42 g. in 10 c.c.)	—	5.0 c.c.
Water (distilled)	—	17.9 c.c.

Fig. 1—Quebec organism.
Fig. 2—Saltation.
Fig. 3—Vermicularia varians.
Fig. 4—Colletotrichum tabificum.
Fig. 5—Colletotrichum at amentarium.
Fig. 6—Colletotrichum atrovirens.

spore suspension was adopted. A stock culture, on potato-dextrose agar, of the organism to be used (which was well covered with spores) was thoroughly stirred in sterile water in the tube in which it was growing. The stirring was done with a sterile glass rod. The suspension was then poured on a screen of fine-meshed muslin in a funnel, and strained into a sterilized flask. This gave a liquid turbid with spores, most of which had been shaken apart and floated free in the liquid. Very little other material passed into the flask. For inoculation one cc. of this liquid was passed into each flask by means of a sterile pipette. This gave an abundance of spores, which were uniformly distributed in the culture media.

The cultures were allowed to grow for a period of sixteen days in an incubation chamber where the temperature did not vary more than two degrees. The chamber was lighted with electric lights all the time during the period of growth. The yield of dry material produced was used as an indication of the effect of the food supplied. The dry weight of material was obtained by filtering through a filter paper which had previously been weighed. The filter paper containing the mycelium was then placed in a drying oven kept at a constant temperature and left there until thoroughly dried. The filter papers were again weighed and the amount of dry weight calculated. All the yields of each series were subjected to the same conditions in drying.

The H–ion concentration of each culture solution was determined before the flasks were inoculated and after the period of growth. The colorimetric method of H–ion determination as described by Clarke and Lubs ('17) and later more fully by Clarke ('21) was used in this phase of the work. From time to time the electrometric method was used to act as a check.

The results of the cultures of the *Quebec organism*, are given in the following table. The results obtained from the other five organisms were very similar to this :

Flask No.	Initial pH.	Final pH.	Dry wt. in gms.	Rank.
11	5.0	5.8	.375	3
12	5.3	5.7	.344	8
13	5.0	5.6	.320	14
14	5.4	5.8	.288	20
15	5.2	5.7	.325	13
16	5.2	5.6	.235	21
21	4.6	5.6	.323	15
22	4.8	5.8	.374	6
23	4.9	5.6	.337	9
24	4.8	5.6	.308	16
25	4.4	5.6	.329	12
31	4.5	5.6	.375	4
32	4.4	5.7	.333	11
33	4.4	5.6	.388	1
34	4.6	5.7	.363	7
41	4.5	5.6	.301	19
42	4.4	5.6	.305	17
43	4.5	5.6	.375	5
51	4.3	5.6	.302	18
52	4.3	5.7	.383	2
61	4.2	5.6	.336	10

Note: These results are the average of two sets of cultures.

The *Quebec organism* grew well in all the flasks with marked similarity in type. For the first week the culture gave a soft, white submerged mycelial growth and on the ninth day a white surface mat had formed which by the eleventh day was showing a pink coloration on the surface of the mat. This pink coloration, on close examination, was found to be due to large numbers of circular pink bodies, hard in texture, which when crushed under a cover glass discharged large numbers of what appeared to be oil globules. By the sixteenth day this pink coloration had changed to dark brown and in a number of flasks to a distinct black. On examination under the microscope this black growth was found to consist of large masses of coalescing sclerotia. No spores were found in any of the cultures examined. The surface layer at the end of the sixteenth day varied in thickness from 1-16″–1-8″.

Vermicularia varians, C. tabificum, C. atramentarium, and C. atrovirens showed the same growth exactly as that of the *Quebec organism.*

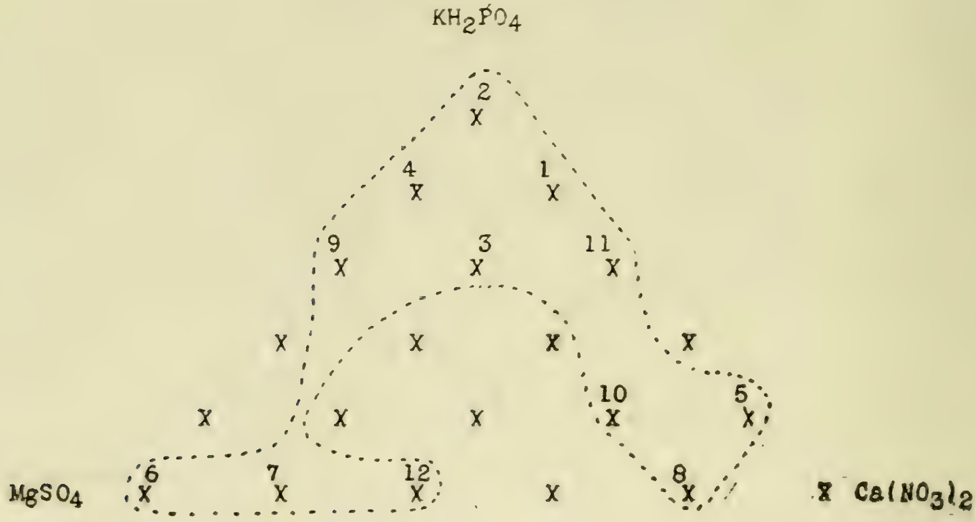
The *Saltation* differed in type of growth from the others in some respects. On the third day small particles of white, downy mycelial growth were visible throughout the liquid. By the twelfth day white submerged growth had become denser while, in some flasks there appeared white horn-like structures protruding from the surface of the liquid. On examination these proved to be dense rope-like masses of mycelium. No pink coloration was noted and no surface mat of mycelium was formed. At the end of the growth period nothing but a submerged mass of white mycelial growth could be seen.

The following diagrams represent the arrangement of the triangular system The area within the dotted lines in each case represents the twelve cultures making the best growth:—

Quebec organism.

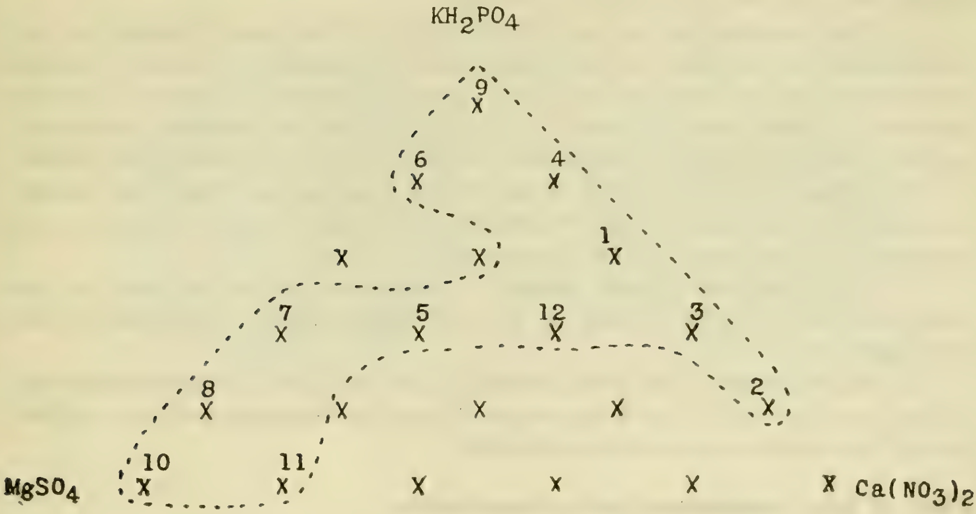
Saltation.

Vermicularia varians.

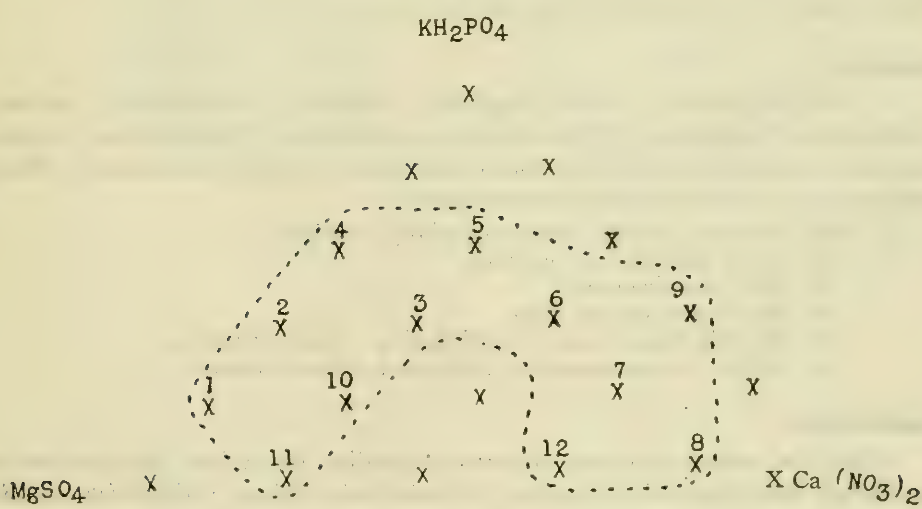


Colletotrichum tabificum.

Colletotrichum atramentarium.



Colletotrichum atrovirans.



From a close study of the preceding table and growth diagrams, the following tentative conclusions may be drawn:

1. The relationship between growth and H-ion concentration for the six organisms was similar, that is, the growth of the fungus for a period of sixteen days caused the solutions in which they grew to become less acid. On the average the change was 1.1., and it is likely that had the cultures been continued for a longer period the change towards alkalinity would have been greater.

2. From the fact that the triangulation diagrams showing best growth are practically the same for all the organisms, it would appear that they are identifical in their nutrient requirements.

3. Since the best growth appears in the flasks nearest the apex of the triangle KH_2 PO_4 may be said to be the limiting factor for growth of the three salts used.

4. With the exception of the *Saltation*, there was a very marked similarity in the type of growth. One organism could not be distinguished from another at any time during the period of culturing.

Effect of light, temperature and carbon dioxide.

As the result of numerous tests it was found that the temperature limits for all the organisms were the same.

Light was found to be responsible for zonation, high color and for a slight retardation in the rate of growth.

Experiments were carried out to ascertain whether the fungi would grow in an atmosphere of carbon dioxide and if so whether any change in the type of growth could be detected. It was found that the organisms growing in the atmosphere of CO_2 were exactly similar to the check cultures in every way. The rate and type of growth were identical.

Summary.

1. Six organisms (*Quebec organism*, *Saltation*, *Vermicularia varians*, *Colletotrichum tabificum*, *Colletotrichum atramentarium*, *Colletotrichum atrovirens*) all causing a disease of the potato were used in these experiments. They were grown on certain solid and liquid media.

2. The following points were especially studied:
  (a) Type and rate of growth.
  (b) Salt requirement.
  (c) Hydrogen-ion reaction.
  (d) Morphological and physiological characteristics.
  (e) Effect of temperature, light and carbon dioxide.

Conclusions.

From the results of the above series of studies, the writer feels justified in concluding that the *Quebec organism*, *Vermicularia varians*, *Colletotrichum tabificum*, *Colletotrichum atramentarium* and *Colletotrichum atrovirens* are identical from a morphological and physiological standpoint.

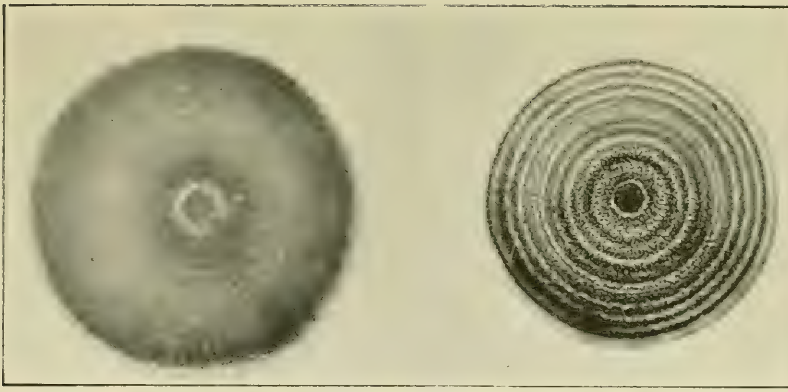


Fig. 1.

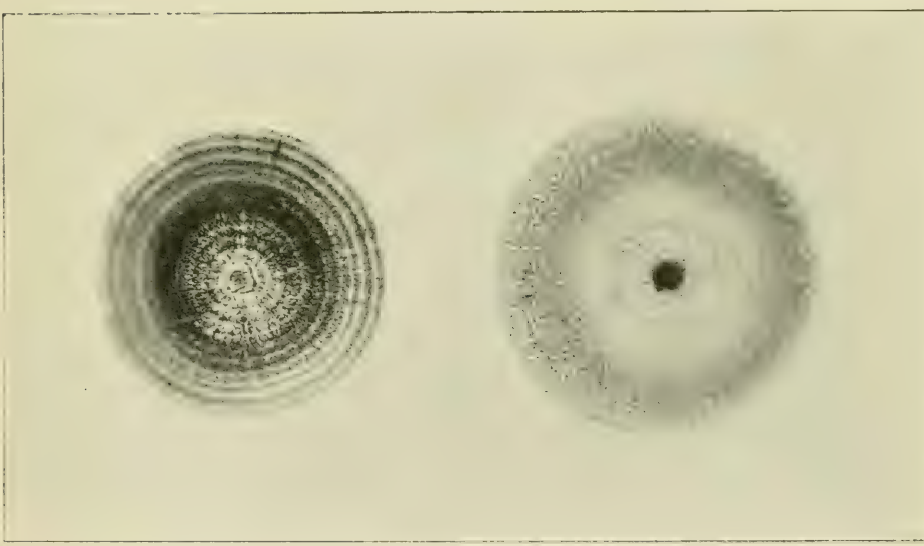


Fig. 2.

Growth in total darkness and in sunlight. Cultures on the left in each figure were grown in darkness, those on the right in sunlight. Note the zonation present to a marked extent, in the cultures grown in sunlight.

Fig. 1—Colletotrichum atramentarium.

Fig. 2—Colletotrichum atrovirens.

The Saltation is similar to the others in every respect, except that no sclerotia develop on artifical media, and, as far as coloration is concerned more yellow than amethyst usually occurs.

This article is an abridgment of a thesis taken under Dr B. T. Dickson in the Department of Botany, Macdonald College, and submitted to the Graduate School of McGill University in partial fulfilment of the requirements for the degree of M. Sc.

In conclusion the writer wishes to express his appreciation to Dr. B. T. Dickson for his valuable advice, and for kindly direction and criticism.

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INDICES TO THE PRELIMINARY LIST OF THE IN SPECTS OF THE PROVINCE OF QUEBEC

(Parts I and II)

Prepared by

Prof. ELIAS ROY, Collège de Lévis,

PART I — LEPIDOPTERA.

Index of Families.

Index of Genera

PART II — DIPTERA

Index of Genera

ABSTRACTS OF CANADIAN PLANT PATHOLOGICAL LITERATURE.

A. W. McCALLUM, Botanical Division,
Central Experimental Farms, Ottawa.

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Faull, J. H. Forest Pathology: In Report of Forestry Branch, 1922. Ann. Rept. Min. Lands and Forests, Ont. for 1921-1922: 245-254. Fig. 5-9. 1923.—"Red branch" of balsam, pine, and cedar due to injury by *Monahamus* spp. late in the season is described. A preliminary description of five types of butt and heart rots of balsam is given.—A list of balsam rusts occurring in Temagami is appended; this includes two new species described by Bell.

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At that time entomology was apparently more highly developed than plant pathology since, of a total of seven chapters.six are devoted to the consideration of injurious insects. In the chapter on wheat diseases rust, smut, and ergot are dealt with and the writer has many quaint misconceptions in regard to the nature of these fungi. Thus, "Rust is the growth of two kinds of fungi. uredo rubigo and uredo linearis". It is interesting to note that the author suspects that the rust spores gain entrance to the wheat plant by way of the stomata.

As for control it is recommanded that powdered charcoal be distributed over the wheatfields in order to absorb the atmosphoric ammonia, which it is believed, favours the development of rust by "stimulating the growth of the sporules in the stagnated juices of the plants." In addition, early sowing and 'the selection of flinty-stemmed varieties whose stomata on the stalk will have in great part closed before the "time for rust" are advised.

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fect control though further work may yield better results. Where seed treatment is not at present practised and where absolute control is not a necessity this form of treatment might be used with advantage.

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SEVENTEENTH ANNUAL REPORT

OF THE

Quebec Society for the Protection of Plants

1924-1925

Supplement to the report of the Minister of Agriculture

PRINTED BY ORDER OF THE LEGISLATURE

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SEVENTEENTH ANNUAL REPORT

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1924-1925

To the Honourable J. E. Caron, M.P.P.

Minister of Agriculture,

Quebec.

Sir :—

I have the honour to present herewith the seventeenth Annual Report of the Quebec Society for the Protection of Plants, containing the proceedings of the winter meeting of the Society, which was held at Macdonald College, Ste. Anne de Bellevue, Que., on Wednesday, April 15th, 1925.

Included are the papers that were read, and the reports of the officers of the Society.

I have the honour to be,

Sir,

Your obedient servant,

E. MELVILLE DUPORTE,

Secretary-Treasurer.

Macdonald College, Quebec.

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Delegates to the Ontario Entomological Society.—Prof. Lochhead and Rev. Father Leopold.

Delegates to the Canadian Branch of the American Phytopathological Society, Dr. B. T. Dickson, Rev. Father Leopold, Mr. O. Caron and Mr. J. J. Coulson.

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Willey, Dr. A.	58 Metcalfe St., Montreal.
White, R. M.	Macdonald College.
Winn, A. F.	32 Springfield Ave., Westmount.
Yauch, C. M.	Agric. School, Olds, Alberta.

HONORARY MEMBERS

James W. Robertson, Esq., LL.D., C.M.G., Ottawa.
Hon. J. E. Caron, M.P.P., Minister of Agriculture, Quebec.
F. C. Harrison, D. Sc., Macdonald College.
Rev. Father Superior Dom Pacome Gaboury, La Trappe, Que.
Auguste Dupuis, Village des Aulnaies.
Canon, V. A. Huard, D.Sc., Quebec.
Rev. Father Superior, Ste. Anne de la Pocatière.
J. C. Chapais, D.Sc., St-Denis-en-bas, Que.
A. Gibson, Esq., Dominion Entomologist, Ottawa.
Hon. Minister of Crown Lands and Forests, Quebec.

FINANCIAL STATEMENT OF THE QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS 1924-1925.

RECEIPTS

Balance forward	$174.49	
Government Grant	250.00	
Interest	6.21	
		$430.70

EXPENDITURE

Delegate to Royal Society	$ 39.05	
Secretary's stipend	50.00	
Delegate to British Association	47.00	
Clerical work	10.00	
Delegates to Phytopath Society	33.80	
Delegate to Ont. Ent. Society	28.50	
Postage	2.75	
Lecturer at Annual Meeting	40.00	
Incidental expenses of Annual Meeting	1.21	
Balance on hand April 30th, 1925	$178.39	
		$430.70

Audited and found correct.

T. G. Coulson.

W. Lochhead,
President.

E. Melville DuPorte,,
Sec. Treasurer.

MINUTES OF THE SEVENTEENTH ANNUAL MEETING.

The Seventeenth Annual Meeting of the Quebec Society for the Protection of Plants was held in the Biology Building, Macdonald College on Wednesday, April 15th, 1925.

The two general sessions were well attended. At the afternoon session Principal F. C. Harrison welcomed the guests and members, congratulating the Society on the good work it is doing and on the progress it has made. The papers read during this session are included in the report.

In the evening Dr. B. T. Dickson gave a short account of the history of the Society. This was followed by the principal address, delivered by Dr. Jas. G. Needham of Cornell University . Dr. Needham's address on "Some New Ventures in Entomology" was keenly enjoyed by the audience, owing in part to the speaker's inimitable manner, and in part to the almost untouched fields of economic Entomology of which we were given a glimpse. This address is printed in the report in a somewhat condensed form.

The business meeting was called to order at 11 a.m. Owing to the absence of the President on acount of illness, the Vice-President, Rev. Father Leopold took the chair.

The minutes of the last meeting were read and approved.

The report of the Secretary-Treasurer was read and accepted.

The following officers were then elected for the year 1925-26.

President:—Prof. W. Lochhead, Macdonald College
Vice-President:—Rev. Father Leopold, La Trappe.
Secretary-Treasurer:—Dr. E. Melville DuPorte, Macdonald College.
Directors:—Prof. E. Campagna, Ste Anne de la Pocatiere.
Dr. A. T. Charron, St. Hyacinthe, Que.
Dr. B. T. Dickson, Macdonald College.
Prof. Father Louis Marie, La Trappe.
Prof. Georges Maheux, Provincial Entomologist, Quebec.
C. E. Petch, Esq., Hemmingford, Que.
Prof. Bro. Victorin, University of Montreal.
A. F. Winn Esq., Montreal.
Auditor:—J. G. Coulson Esq., Macdonald College.
Delegate to the Royal Society of Canada:—Dr. Dickson.
Delegates to the Canadian Branch of the American Phytopathological Society:—Dr. Dickson, Rev. Father Leopold, Mr. O. Caron, and Mr. J. G. Coulson.

A Committee was appointed to assist the Ontario Entomological Society in making local arrangements for their Annual Meeting to be held in Montreal, in November. The members of this Committee are Prof. Lochhead, Mr. Petch, Mr. Winn, Father Leopold, Prof. Maheux and Dr. DuPorte.

On the motion of Mr. Arthur Gibson and Dr. B. T. Dickson the Secretary was directed to send a telegram to Prof. Lochhead regretting his illness and hoping for his speedy recovery.

The Society delegated Prof. Maheux to interview the Minister and decide on some definite policy regarding the supplying of separates to contributors.

It was resolved that as far as funds are available the Society should continue to make grants not exceeding fifty dollars in aid of investigations on plant diseases caused by insects fungi or bacteria it being understood that the report on such investigations shall be presented to the Society at its Annual Meeting.

SOME NEW VENTURES IN ECONOMIC ENTOMOLOGY

By James G. Needham,

Prof. of Entomology and Limnology, Cornell University.

In the economy of nature insects play a large part. I invite your attention to their role as agents for the turnover of plant food materials. It is a double role. In the first place they eat plant stuffs both living and dead more in the aggregate than does any other class of animals and by the disintegration of these stuffs they restore the organic materials of the world's food supply to circulation. Thus they aid in the maintenance of a richer and more abundant life upon the earth. In the second place they themselves become food for the carnivores. Of the world's supply of flesh for land animals they are the major part. Practically all land carnivores eat insects and some of them eat mainly insects. Though insects are no part of our diet they have much to do with the maintenance of our diet; and it is of the part they play as agents of food turnover that I wish to speak. They directly feed some of the best of our game birds and food fishes and are often the limiting factor in the production of these choice human foods.

Perhaps we may derive some useful ideas concerning animal forage by recalling how the betterments in our own diet were made.

Mankind at the first lived as do the wild beats on what nature furnished ready made. *All men were sheer exploiters.* Then they learned the use of fire for cooking and of *simple tools for cutting* and for crushing food products; thereby they greatly increased the range and variety and value of their diet; but they were still exploiters. Then they selected a few of the most useful plants and animals *and by care* and culture of them vastly increased their product. This is *the essence of agriculture.* This laid the basis for our civilization by providing a larger and more dependable food supply. This made possible

a larger *population with settled homes* and with increase of leisure and of opportunity for taking thought.

A little more thinking is always in order. It is the prerogative of our species. We get on by thinking upon the ways of nature, and by imitating them under altered conditions that yield better results. Since the human population has almost overtaken the food supply and is ever on the increase, if we would not rob the earth of every remaining element of primeval beauty or potential benefit, it behooves us to be taking thought of better ways for utilizing the part of it that we have already despoiled. We have fields enough for the present, and far too many wastes. In our utilization of plant products there are great losses. Usually, about one part is saved and three parts thrown away. And about in proportion to the richness of its organic content, the part thorwn away becomes a burden of offense. Nature has many agents for the reclamation of these rich wastes, and we may learn to use them to our profit by taking thought.

The earliest of our betterments consisted in the mechanical treatment of natural products. The devices were very simple; a flat stone for cracking nuts; a hollow stone for pounding acorns; a mortar and pestle for grinding grains. The last was a simple mill, and complicated mills followed afterwards and made bread for our species "the staff of life'. Though we have long been dependent on mills for the preparation of the cereal staples of our diet, we have little considered what mechanical treatment might do by way of preparation of food for some of the lesser organisms.

It is insects I have in mind: herbivorous insects that are themselves the food of some of our most desirable birds and fishes. I have been directing some experiments in the mechanical preparation of foods for them in the hope of obtaining a more abundant supply of them for feeding purposes; and of the results of these experiments I have come before you to make preliminary report.

The larvae of certain midges and flies have been the subjects. The midge first use was *Chironomus decorus*. Larvae of this species hatched from the egg in our aquaria were reared to full naturity on a diet of a single species of pond weed, *Potamogeton crispus*. This plant is not normally eaten by the larvae, but when its substance was made available by grinding it proved a very satisfactory ration. This work was done by Miss Ruth Tillbury and the details of it were published by her in the Journal of the New York Entomological Society.

> [The speaker here digressed to mention and to illustrate with lantern slides the work done by P. W. Claassen and Miss Hazel E. Branch on utilizing the larvæ of another midge, *Chironomus cristatus* for clearing out milk wastes in streams. Details of this work have been published in Bulletin of the New York State Agricultural Experiment Station.]

A more extended series of experiments was concerned with providing suitable food for the larvæ of the fly, *Muscina stabulans*. I was drawn into this study by discovering the need of our game bird breeders for suitable insect

food for young pheasants. There is a time in the life of young pheasants before their stomachs are able to digest grain during which they seem to require insect food. Meal worms have been found excellent but they are too expensive to buy and too slow to raise. Blowfly maggots have been found suitable food but the rearing of them in carrion is a thouroughly obnoxious task, which no one likes to perform. The question arose in my mind. Why not use the larvæ of some vegetable-feeding fly and avoid the stenches? It was Miss Laura Florence, who in some initial experiments determined for me that the pulp-feeding larvae of *Muzcina* seem most suitable, and it is these larvæ that I have since been raising. Mishaps and failures by the way, need not be recorded here. Suffice it to say, that a very simple plan has been evolved, the essence of which is the mechanical treatment of more or less succulent green herbs to make their protoplasmic contents available. This is merely the application of the ancient processes of cutting and grinding to disrupting the protective layers of cellulose and lignin, thus exposing the stuffs on which the larvæ may then feed. A great variety of weeds have been used successfully; burdock, sweet clover, dandelion, plantain, etc. These are prepared for use by being run though a green food cutter, such as poultry-men use, and then thourgh a sausage mill and thus reduced to a soft pulp. This pulp intermixed with a little yeast from an old culture is spread out in pans, sprayed with a little cider vinegar to check the growth of mould and to prevent that of yeasts, a little brown sugar is added for bait, two days are allowed for fermentation, and then the pans are exposed in a cage with the adult flies. These, if sexually nature, lay their eggs either on the pulp, or if it be very moist on the sides of the pan just above its surface. Within ten days the larvæ are full grown. The pans are dumped out on the ground in the yard and the young pheasants do the rest.

Here is a phenomenally quick turnover of green plant stuff into flesh. On such food carnivorous birds and fishes thrive, and I see no reason why it may not be provided easily and cheaply in any desired quantity; but the production of it is still a new venture, as my title implies, with many details of the methods still to be worked out.

Since so many unused and often noxious plants have been found suitable sources of food for these larvae, and since they may be equally good food for other birds, such as young turkeys and for fishes, I anticipate that the results of these experiments may find a wide application. May we not have tapped a new source of food supply for human kind by this unexpected route and another aid to the maintenance of our ever increasing population?

[The Speaker then called attention to the simplicity of structure of the *Muscina* larva and to the shifting of metamorphosis that make possible its rapid growth, and then spoke further concerning insect larvae in general as follows:]

The insect larva is an unparalleled biological phenomenon. Oken called it an embryo at large. And so it is; but it is far more than this. For instead of

living its life at the expense of its forebears, after hatching from the egg, it, in its own brief time, accumulates for itself all the materials for the growth of a lifetime. It is a model of fitness and efficiency. It is of about the optimum size for taking advantage of scattered food supplies, as the world offers them—big enough for efficient operation—not so big but that a livelihood may be found in numberless places. It is a simplified arthropod, with all redundant and unnecessary parts removed. No cumbrous parts of the adult insect appear: nothing appears but what is necessary for getting a living and keeping alive; feeding organs and means of keeping to cover; that is all; an irreducible minimum!

The larva represents a segregated period in the life history of the insect—a period of food accumulation and growth. The complicated organs of the adult insect, wings, antennæ, etc., are not seen in the larva. They are present as small rudiments, biding their time, waiting for a more favorable season for further development, waiting on the more important and more pressing business of food-getting. The larva is preeminently fitted for "making hay while the sun shines". More than any other animal of comparable size it lives on perishable and transient foods, and it lives among a host of greedy competitors. It must work fast, and lay up stores. It uses a little food to build such organs as are immediately necessary; the remainder it stores as fat. When it is fully fed it is largely a mass of fat, with a few old and more or less effete nutritive and motor organs disposed through and around the body, and with only the rudiments of adult organs.

Then comes transformation. The larva goes into retirement, and ceases activity. The pupal stage is entered upon. Another marvel ensues. The animal though grown to its maximum size, now returns to a condition comparable to that of an embryo. The rudiments of the adult organs begin to grow. They feed upon the store-up fat, much as in the egg the initial larval organs fed on the yolk therein. Though these rudiments are scattered about the body, they are bound together with the thread of life; they grow and shape themselves and and organize into the perfect insect, with all its organs, all its powers, and all its endowment of inerited behavior.

Clearly the larva would be a helpless, hapless, hopeless thing without the nstinctive aid of the mother insect to place it in reach of its proper food.

Such is metamorphosis at its best, truly a world phenomenon, and so manifest only in a portion of the group of insects, a life cycle broken into two periods, corresponding to the two great undertakings of life, growth and reproduction, and separated by a stage for the making over of the one into the other.

Of all biological expedients metamorphosis is clearly one of the most successful if success is measured by dominance. The group of insects outnumbers in species all other kinds of animals put together, and four orders of insects in which metamorphosis is completest are so preponderant that all the others taken together seem but a handful in comparison. These four are the Lepidop-

tera, the Coleoptera, the Diptera and the Hymenoptera; and within these orders those families in which metamorphosis is completest are the large and dominant families.

The one persistent trend through orders and families alike has been toward one type of larva: simple and worm-like, legless and lacking all other appendages, with even the head reduced but with the abdomen enlarged and full of fat, capable at last of only a sheltered existence, and requiring, for the final making over, a pupal period of complete quiescence.

This phenomenon interests us all as biologists; but it is to the food-producing capacity of these larvæ that I am particularly inviting your attention at this hour. Among insect larvæ are to be found the best agents for quick turnover of common plant stuffs and of organic wastes into fresh food for canivorous animals.

The young of many of our most desirable food species of both birds and fishes seem to require for their best development a diet of insects. On such a diet they have been evolved. To it they are fitted. On it they thrive. Our success in rearing them has been demonstrated to depend on furnishing them with such a diet; but hitherto this has been done in a desultory way and with great uncertainty as to continuity of supply.

The requirements are three—the same as for raising any other animals whatsoever:

1. Suitable food in adequate supply.
2. Suitable shelter including defence against enemies.
3. Maintenance of conditions suitable for growth and reproduction.

The only impediment is ignorance, and lack of scientific method. The cure for this is research; patient, sustained research, and reflection on the ways of nature, and on how we may better adapt them to our own needs. By this means we have made all the betterments of our civilization; and in my judgment the thoroughgoing economic exploration of the world we live in has only just begun.

APPLIED ENTOMOLOGY IN RUSSIA

By Prof. W. Lochhead, Macdonald College.

While in London from January to April, 1924, the writer was fortunate in meeting Prof. B. F. Uvarov of the British Museum of Natural History, who is one of the most prominent of the younger Russian entomologists. He was good enough to give the writer much valuable information regarding entomology in Russia, and through his kindness several abstracts and translations of papers and addresses of an historical nature were secured which the writer has used quite freely.—)

The study of insects in Russia has been carried on mainly by four sets of agencies: the **Entomological Societies**, the **Museums**, the **Bureau of Applied Entomology, and Local Stations and Bureaus.**

1. The Societies:

The Russian Entomological Society, Petrograd, founded in 1850, is the oldest of the Societies. A short history of the period 1860-1910 was published in: ' Horae Societatis Entom. Russicae", XXXIX, 1910; Annual reports for 1911 to 1915 are published in the "Revue Russe d'Entomologie" while the report for the years 1916-1920 is to be found in the "Bulletin of the Second Entomo phytopathological Conference in Petrograd"

The Entomological Society of Moscow was founded in 1914, and three volumes of the Reports have been published in the: "Bull, de la Soc. Ent. de Moscow".

The Russian Association of Economic Entomologists was founded in 1913 at Kiev during the First All-Russian Entomological Conference. Two volumes of the "Russian Journal of Applied Entomology" have been published. During the war its work was largely suspended, but its activity was revived in 1922, at Moscow.

2. Museums:

The Zoological Museum of the Russian Academy of Sciences, Petrograd is a very old (nearly 100 years) institution, with a large entomological department, where enormous collections especially of Palaearctic insects are accumulated. Reports on the work may be found in the yearly volumes of the "Annuaire de Musée Zoologique de l'Academie des Sciences."

The Zoologica Museum of the Moscow University. This museum is not so important from an entomological point of view as the Petrograd Museum, but a certain amount of systematic work is carried on there

The Museum Caucasicum now called Musée de Georgie, in Tiflis, Transcaucasia, possesses very rich collections of the entomological fauna of Caucasus. Persia and Armenia, and has published a series o' annual reports.

Small provincial museums, with entomological departments, are in Kiev, Ekaterinburg, Minussinsk, Tomsk, Tashkent, Stavropol, Simferopol, Kherson.

3. The Bureau of Applied Entomology of the State Institute for Experimental Agriculture, Petrograd, was founded in 1894. A short history of this Bureau was outlined in a paper by Bogdanov-Katkov (1923); while the present organization and plans for the future are given in another paper by Prof. Pospelov, present Chief of the Bureau.

4. Local Stations and Bureaus.

These are about fifty in number. A history and brief summary of organi, zation and work up to 1915 is given by I. I. Mamontov.

When one is informed that the complete list of Russian literature on Ecnomic Entomology occupies over 200 pages of small type, in two columns, in a forthcoming publication of the **Review of Applied Entomology,** one begins to wonder if he is not playing the part of a new Rip van Winkle who has slept while the world has progressed. Russia has been to a large extent cut off so

long by the barrier of language from the rest of the world that the great work she has done is known only to a few of her nearest neighbours and to occasional visitors from the West.

Some of the first references to Russian insects in American literature are found in the First and Second Reports of the U. S. Entomological Commission relating to the Rocky Mountain Locust (I. pp. 467-475; II, pp. 35-41), where excellent accounts are given of the devastations caused by locusts in Russia; also good descriptions of the habits and life-history of the Russian Migratory Locust (taken mainly from Köppen's Memoirs).

The work of Russian Entomologists was again brought to the attention of American students through the introduction of the Gipsy Moth into New England. It was there found that this insect had been a serious pest to forests and orchards for many years in southern Russia. In the well-known work of Forbush and Fernald on "The Gypsy Moth" (1896) a good record is given of the references to the economic works of Keppen, Rudsky, Forchinsky and Hulagin of the distribution and depredations of the Gypsy Moth.

Later the Bureau of Entomology of the U. S. Department of Agriculture sent experts to Russia in an effort to obtain parasites of the Gypsy and Brown Tail Moths. In 1907 Dr. L. O. Howard visited Kiev, Odessa, Kishenev and the Crimea, and got into touch with the eminent entomologists, Forchinsky, Pospielov, Krassilstschik and Moktzhecky. In 1909 Prof. Trevor Kincaid went to Russia and studied the situation at Kiskenev and Kiev; and Mr. W. F. Fiske spent a few weeks in Kiev and Kharkov provinces in 1910. (Bull. 91, Bureau of Entomology).

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THE DEVELOPMENT OF ENTOMOLOGY

(Based on a Paper by Bogdanov Katkov given in 1923.)

Up to the middle of the last century entomology in Russia was studied only by a few individuals, and many of those were foreigners. Among these may be noted K. Laxmann, P. C. Pallas T. G. Girelin, T. Zzderhelm, T. A. Dvigoubsky, D. Goummel, G. T. Fisher, F. Faldermann, R. G. Mannerheim, E. A. Eversman, H. H. Steben, B. G. Besser, V. T. Motchoulsky, V. P. Zoubkoff, A. D. Nordman, and T. F. Escholtz. About 1850 however an organization called the Russian Entomological Society, was formed but it was not until 1859 that the constitution of the Society was decided. From the beginning of its existence this society has given considerable attention to economic and applied entomology, and during its first year a special committee of six persons was appointed to deal with insect pests. In 1862 the committee with 1500 roubles at its disposal, invited A. A. Koushakevitch to investigate locusts, T. U. Simasjko forest insects, chiefly bark beetles in the province of Petersburg, and O. B. Bremer cutworms in the province of Kostroma. In 1867 F. P. Kepper studied the locusts in the Crimea, and L. F. Rougsky the hessian fly and the gypsy moth. After 1868 the special committee ceased to function, its work being taken over by the secretaries of the Society who frequently sent its members to investigate the outbreaks.

About 1876 owing to a series of severe insect outbreaks that occurred throughout the whole of southern Russia, the local authorities were forced to demand help from the universities and the Department of Agriculture, and to request the formation of entomological centres in Kharhov and Odessa. As a result, the first "Entomological Commissions" were established, that at Kharhov in 1878 and that at Odessa in 1882. To the former belonged the noted scientists Metchnikoff Zenhovsky, Yaroshevsky and Stepanoff. The work in Odessa was under the direction of Yakounin. As the members were mostly university professors and instructors they could devote but a part of their time to the work. Much valuable work was done, however, and several conferences of entomologists from eleven of the southern provinces were held. At the 7th conference at Odessa the post of "regional entomologist" for the whole of south Russia was established and given to P. A Sabarinsky.

In 1892. when a very serious outbreak of *Eurygaster maurus* destroyed about 60,000 acres of wheat in the Crimea, the local government decided to establish the post of "provincial

entomologist" with A. Mokrzhecky as first occupant. In spite of great hand caps of lack of equipment, scientific help , money and mistrust on the part of the people, Mokrzhecky worked courageously alone for fifteen years, and made many contributions to entomological literature. He made observations on about 500 species of insects, and published over 350 papers in less than 20 years.

Following the example of the Crimea, many other local governments (Zemstvos) soon opened their own entomological stations.

As a further development of the idea of a more intensive study of insect pests by the limitation of the working area, the Board of Directors of the South Russian Agricultural Socie y in Kiev in 1903 requested the Department of Agriculture to establish a post of en omologist, the Society offering to pay all the expenses in connection with the equipment of the laboratory and the local work of the entomologist. In the following year (1904), t e Department approved of the formation of an "entomological station" in the South Russian Agricultural Society. Similar entomological stations or bureaus were soon opened in other places. In 1916 twenty one such station were operating, and now (1923) there are over fifty.

If, in addition, the permanent entomological organizations that are connected with the local natural history museum in Kherson (since 1897), in the Crime (since 1899.) and other places are taken into consideration, it will be seen that most of the provinces of Russia concerned with grain growing are supplied with organizations for dealing with insect pests.

The need for a central bureau of entomology had been felt for many years, by the Russian Entomological Society and in 1894 the Bureau of Applied Entomology of the State Institute for Experimental Agriculture was founded in Petrograd under the leadership of T. A. Porchinsky. It has been very successful, and the investigations of Schreiner, Vasiliev, Rossikov, Dobrodere and Porchinsky relate to the most important pests of Russia. The publications of the Bureau are the best on the subject in the Russian language. However, the success of the Bureau has been the means of centralizing the work in Applied Entomology instead of founding and supporting local entomological institutions in different parts of Russia.

The development of entomology in Russia has been very rapid since 1895. As has been said the first provincial entomologists had neither microscopes nor equipment, and worked under many adverse condit ons, but in 1905 more than ten well organized institutions with experienced entomologists and assistants existed, and in 1910 there were over 100 persons giving their attention to applied entomology.

When the Russian Entomological Society was founded (1850), there were only 102 entomologists in Russia, more than half of them being amateurs, while only three or four persons worked in applied entomology. In 1910 the number of entomologists were 340, and in 1923 there were 288, a reduction due to the Great War and Revolution.

Before 1890 entomology was not taught anywhere as a separate subject, but as a part of the general course of zoology. Since, however, more attention has been given to the science by the universities at Warsaw, Moscow, Kharkov, Petrograd, Kazan and Kiev. In addition, economic workers have been trained at the Petrograd Institute of Forestry where a school was organized by Cholodkovsky, at the Agricultural course of Petrograd under Silanter. at the Moscow Agricultural Academy where a school was organized by Koulagin and Boldigraff, at the Novo-Alexandra Agricultural Institute were students worked under Tarnani, and at the Polytechnic of Kiev. Moreover, many of the entomologists were trained at the entomological stations, at Kiev under Pospeloff; at Kharkoff under Averin; at Plotava under Rourdumov; at Stavropol under Uvarov; and in the Crimea under Mokrzhechky. Often the training was completed in the Zoological Museum of the Russian Academy of Sciences, in the Russian Entomological Society, and at the Northern Station for Protection of Plants at Petrograd.

LOCAL INSTITUTIONS FOR CONTROL OF PESTS OF AGRICULTURE

Entomological and Phytopathological Stations and Bureaus.

ENTOMOLOGICAL STATIONS IN RUSSIA

(Based on a paper by I. I. Mamrilov in 1915, head of the Entomological section of the Minister of Agriculture and initiator of nearly all the Entomological organizations.)

General Description:—

Entomological stations are very recent institutions both in Russia and in other countries The necessity of organizing a systematic study of insect pests with the object of finding only the best means for destroying them was first felt in the United States where in 1854, the post of entomologist was established by the Agricultural Society of New York State. In Russia the question of instituting an establishement of this kind was first discussed in 1883 at the first entomological

Conference in Odessa, which was called mainly for discussing measures of destroying *Anisoplia* a genus of chafers. As a result of the decision of the Seventh Entomological Conference in Odessa there was established at the Entomological Commission of Odessa a post of economic entomologist supported by the joint funds of all the zemstvos (1) that took part in the work of this Commission. Thus was started the local entomological organization.

The question of a systematic study of pests of agriculture, which was first discussed at the First Entomological Conference at Odessa, was only taken up twenty years later. In 1903 the Board of Directors of the "South Russian Society for Encouraging Agriculture and Rural Industry in Kiev presented to the ministry of agriculture a memorandum pointing out the great amount of damage caused to agriculture, in particular to the beetroot plantations in the South-western region and the provinces next to it, by different insect pests and asked that a post of entomologist to the Society be established at the joint expense of the Society and the Department of Agriculture, and promising to finance all the expenses incurred in equipping the entomological laboratory for the work of the entomologist. This request was at first declined owing to the fact that the need of entomological help in the south-western region was already, to a certain extent met by the yearly despatching there of the entomologists of the Department; but next year the Department of Agriculture saw its way to change its decision, and on February 24th it issued a regulation to establish an entomological station in the South Russian Agricultural Society.

Following the example of the entomological station in Kiev, other parts of Russia soon opened stations and bureaus of this kind and by 1916 there were already 16 such institutions. The aim of these institutions was threefold:—

1. The study of pests in their particular region, and determining the best means, according to local conditions, for destroying them.
2. The dissemination of knowledge regarding the best means of destroying such pests among the peasants and owners of land.
3. The direction of measures for destroying such pests, should they appear *en masse*.

Of these three problems, the most important for all the entomological stations and bureaus was the last one; that of directing measures for the control of insect epidemics. This was the more important because most of these stations and bureaus were founded when it became absolutely necessary to take immediate measures for destroying the insects. This direction was of such a character that the staff of the establishments not only organized but also took part in the execution of the control measures.

This field of activity took up most of the time of the staff and hindered the development of other lines of work, so these institutions naturally made it their aim to persuade the peasants to handle the different measures for destroying the pests *en masse* under the guidance and instruction of specialists from the station or bureau, or the properly instructed agronomist, or some other suitable member of the staff.

The dissemination of knowledge about pests with rational means for destroying them among the peasants was found to be a difficult problem. It was all the more difficult because the institutions had to reply to the questions of peasants and of owners of land concerning not only the destruction of insect and animal pests, but also the control of plant diseases.

Under such conditions, in the course of time there naturally arose the advisability of separating the phytopathological questions form the purely entomological institutions. The first entomological institution to do this was that of Kiev, which was reorganized in 1913 into a station for the protection of plants from pests.

The idea of dividing an institution into separate sections according to the established classification of the harmful organisms, was most fully expressed in regulations issued in 1916.

The regulations (2) divide the staffs of these bureaus into specialists in the three following subjects:—

1. Applied entomology;
2. Applied zoology; and
3. Phytopathology.

thus dividing these institutions into three separate sections.

Moreover, these institutions are obliged to consider the fact that, apart from more or less known insects and fungous pests, there exist other pests from which the cultivated plants occasionally suffer, but which have not attracted the attention of the peasants owing to the insignificant harm done by them.

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(1) Local provincial government.

(2) Worked out by B. P. Uvarov, who was entrusted with organization of plant protection in the Caucasus in 1915.

On this account and through the necessity of having collections of insect pests of their district for purely practical purposes, such as demonstrations during lectures, exhibitions, etc., and also the need of lending such collections to schools, cabinets of the local agronomists, (1) etc. the institutions were obliged to collect all pests regardless of the amount of harm done by them. The collected material is then sorted, and studied with the help of institutions such as the Zoological Museum of the Academy of Sciences, the Central Phytopathological Station, etc. Accordingly there gradually developed a close connection between the entomological institutions and the Central Scientific institutions.

The collections become all the more valuable if they present the whole life history of pests, for it is possible to fight against them in one or other of their stages with the greatest success, only when the conditions in which they live during different stages of their development are fully known.

Special attention is therefore paid by these institutions to observations on the pests in their natural surroundings, on plots of land specially set apart for such experiments, in gardens, etc., or other observation points, with the further confirmation of these observations in laboratories, where cages are used in the different stages in their development. In this manner the problems of these institutions came to a certain degree in contact with problems attacked by institutions of a purely experimental type.

The experimental institutions have this advantage over the others in that they can confirm their observations, taking into consideration the factors which have their effect upon the cultivated plants and consequently on the organisms which live on these plants. Therefore those institutions whose principal purpose was to help peasants to destroy pests, being deprived of the necessary means (such as specially prepared plots of land), usually did not attempt to find means of thus destroying these insects which are not yet fully known.

Thus a dividing line crept in between the entomological or phytopathological bureaus and the entomological or phytopathological stations. This line, owing to the weakness in the development of the respective sections of experimental stations, is not yet clearly defined, and the research functions, especially in cases of absence of an experimental institution in the particular region, are so far as possible performed by the bureau. This part of their work cannot claim to be thorough and complete as will be clearly seen in the description of the entomological stations and bureaus given later on. At the same time in some cases, especially where there has been formed a close connection between the entomological bureau and experimental institution, the applied scientific investigations have been fairly well developed.

To the investigational work must be added the testing of different substances and apparatus for destroying the pests, which was done by many entomological stations and bureaus. In some cases the results of these experiments proved to be very important in organizing control measures (for example, the testing poison baits to destroy locust proved the possibility of adopting this method, which is much cheaper and simpler than spraying the plants with poison.)

If the measures for destroying insect pests *en masse* have more or less reached their aim, the same cannot be said about demonstrating to peasants the means for destroying pests, for in many cases this part of their work has not been fully and widely developed.

The reason for this lies in the fact that owing to the smallness of their staffs, the institutions were not in a position to do the work, while the local agronomical staffs, whose work it really should have been, usually proved themselves insufficiently prepared for it. Therefore, many stations and bureaus tried to organize a special staff of instructors in insect control from among the local agronomical staffs, by giving special courses of instruction.

Besides this, some of the isolated entomological institutions with their own forces made demonstrations of control measures to the peasants, by means of "flying detachments".

As the success of demonstration work depends upon the facility with which peasants can obtain the necessary apparatus for using different kinds of substances for destroying pests, special attention was paid by the entomological stations and bureaus to enable the peasants to obtain such apparatus more easily by establishing store houses in the institutions; in addition measures were taken that the storehouses should sell only those apparatus and substances which had already been tested by the entomological institutions.

As to the other work of the station entomologists, the most highly developed part of it was the consultation work.

Entomological stations and bureaus, being first of all the advisers of the respective local institutions, are often requested by them to discuss at conferences, meetings, etc. different methods of destroying agricultural pests. At the same time they are obliged to give advice to those who ask for information, advice or directions. These purposes are accomplished by the staffs in two ways:—

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(1) Local instructors in agriculture.

1. By organizing all kinds of lectures, discussions and demonstrations on the subject of destroying agricultural pests, either at the stations or bureaus, or at the place where help is wanted;
2. By correspondence and personal intercourse with (a) regular correspondents of the station who periodically supply the entomological institutions with information about pests, and (b) with occasional correspondents who write, enquiring regarding the particular agricultural pests which interests him the most at that moment.

As to lectures and discussion on the subject of agricultural pests, these are varied both as regards subject and length. Apart from lectures on subjects suggested by the needs of the moment, such as the appearance of some particular pest, or the necessity for doing some seasonable work for destroying pests), which lasted a comparatively short time (one or several hours), the entomologists and mycologists organized lectures and discussions on broader subjects which lasted several days, and which somewhat resembled the regular courses.

Regarding the consultative correspondence with individuals, some of the stations and bureaus made it their special aim to develop this part of their activity. This proved to be possible in those cases where the station or bureau succeeded in securing a number of permanent correspondents and led to the framing of special forms of answers to certain enquiries.

Closely connected with such consultative work was the popularizing of entomology, which, was done by the publication of many kinds of popular leaflets and pamphlets and the contributions of popular articles by specialists to local periodical agricultural journals. Many stations and bureaus issued tens of thousands of such publications which were distributed as widely as possible in the region.

Lastly it must be stated that entomological stations and bureaus sent their representatives to other regions for the discussion of questions relating to the destruction of agricultural pests. These conferences served as a helpful bond of connection among all the institutions.

The question of forming such permanent connection, by instituting a special permanent central bureau, was discussed at the meeting of the Russian Association of Economic Entomologists in October, at Kiev 1916, which consists of representatives of all the economic entomological establishments.

ENTOMOLOGICAL STATIONS IN RUSSIA

1. North Western Region:—

The Baltic station for the protection of cultivated plants from pests (1) is the only one in this region.

This Station has existed in Riga since 1914, and includes a special 'Division of Forest Entomology" under the direction of a specialist-entomologist. Here the pests of forest and decorative trees, and to some extent fruit trees and shrubs are studied exclusively. Special attention is paid to those insects which cause the most frequent and greatest damage to trees on the Baltic coast.

2. Warsaw Province: (2)

In this Province is the Experimental entomological station in Borovock near Warsaw, of the Society of Lovers of Nature in Warsaw.

This station was founded in March ,1913, by the Society of the Lovers of Nature, and its activities commenced in the beginning of June of the same year. One of its foremost problems is the study of the biology of garden pests of the region, with the object of organizing measures for coping with them. Besides this, the station made observations on species of Elateridæ and on *Aphis papaveris* which injure the beetroots. In the end of September, 1914, the two-storey stone building of the station suffered from war activities, and the greater part of the property was destroyed. (3)

3. The Central Region:—

This region consists of the provinces of Kaluga, Tula, Kjazan, Voronezh, Orel, Kursk, Kharkov and Poltava. There is a permanent entomological organization in each of these provinces, the oldest of which is that of Tula.

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(1) At present not in Russia, as Baltic provinces are independent.

(2) At present in Poland.

(3) At present the entomological organization in Poland is being re-organized under the direction of Prof. S. A. Mokrzehcky, a well-known Russian entomologist, and a Pole by birth.

Tula Entomological Station:—

Since 1897 a great deal of harm has been repeatedly done to the agriculture of Tula by the appearance of different insects, mostly Hessian fly and cut-worms. These losses at last attracted the attention of the Zemstvo of Tula, and at the conference of the local authorities held in Tula in 1909 it was decided to ask the government for 25,000 roubles (1) for the purpose of controlling the insects, and also to request the Ministry of Agriculture to establish an entomological station there.

Permission to establish an entomological station was given by the Ministry on March 9th, 1910.

With the object of studying the harmful insects of this province the station made a special effort to make its observation as far as possible in natural surroundings, and at the same time in different parts of the province. To this end the station secured a number of temporary experimental plots of land in those parts of the province where the pest to be studied was found in largest numbers. The experimental plots organized in this manner enabled it to find out the connection that existed between the life of the pests, their number, the amount of harm done by them, and the economic and other conditions of the given region. In all the experimental plots the same programme was followed, making as far as possible the same kind of experiments, thus following the principle of multiple experiments which was found necessary at the agricultural experimental stations. The experimental entomological plots should be as far from one another as possible and cover the entire region. The Tula Station has always followed these principles in studying the insect pests of this region.

Among these insects, special attention was paid to:—

1. *Euxoa segetum*,
2. Hessian fly,
3. Frit fly, and
4. Clover pests, *Apion spp.*

Through the work of the station in studying Apions, the Department of Agriculture suggested to the Zemstvo of Tula to call together a special conference to consider clover pests in general in Central Russia. This conference took place March 27-28, 1915.

Kharkov Entomological Bureau:—

On January, 14, 1905, a meeting of the Zemstvo of Kharkov decided to open a credit to defray expenses of entomologists for the study of the life of insect pests in the province of Kharkov for the purpose of destroying them. The Zemstvo invited two entomologists and thus the systematic study of insect pests was started and the local entomological bureau founded. Although the economic entomologist recorded a considerable number of insect pests (altogether 66 species, among them 29 field pests, 28 garden pests, 8 orchard pests and 1 forest pest), with few exceptions no special harm by the pests has been observed during the last few years.

The study of the pests is done by means of excursions made both by the personal staff of the bureau and by the help of local agronomists and instructors.

In order to inform the population of the nature of its work, the entomological and phytopathological bureau has edited since 1913 a bulletin on the subject of agricultural pests, and measures for destroying them. The bulletin is published periodically seven or eight times a year.

To complete the description of the study of insect pests in this province, it must be stated that these matters also constitute part of the duties of the entomological section of the economic station of Kharkov, but this section is not yet fully organized, and is not, for the present, capable of doing any systematic work. The staff of the section (the director and his assistant) succeeded in obtaining a considerable amount of information about the pests found in fields, and particularly the pests found on grasses, also about *Gryllotolpa vulgaris* Sem; at the same time they study the question of methods and the technique of experimental work;

Kaluga Entomological Bureau:—

Kaluga Entomological Bureau was founded in 1912. During the two years of its existence this institution could not develop all its activities. Special attention was paid by these entomologists to garden pests, for gardening plays an important part in the economics of this province. Among the field pests if this province the most important ones are the wire worms *Agriotes lineatus* L. and *A. sputator* L, also *Euxoa segetum* Schiff.

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(1) $12.500,

Kursk Entomological Bureau:—

Established in 1913, this entomlogical bureau studied mostly the orchard garden pests, chiefly the *Aphids*, *Phytoptus pyri* and Codling Moth.

Voronezh Entomological Station:—

Established in 1912. Observations made in 1912 proved that many insect pests were present, the most important ones in relation to agriculture being *Anisoplia*, Hessian and Frit fly, wireworms, cutworms and *Phlyctaenodes sticticalis*.

Among the insects that injure stored corn, *Calandra granario* attracted the Station's special attention from the first year of its existence.

Orel Entomological Bureau:—

This bureau has existed since 1912, and its personal staff consists of an entomological instructor and a preparator. As most complaints were aroused by the harm caused by Elateridæ, the bureau made one of its chief problems the study of these pests, particularly *Agriotes lineatus* L. Besides this, the bureau made special studies of *Euxoa segetum*, on the genus *Apion*, *Sheimatobia brumata*, and others.

Poltava Entomological Bureau:—

An entomological research experimental institution has existed in the province of Poltava since 1910, namely the entomological section of the experimental station in Poltava (1). The work of this section could not, however, satisfy the growing needs of the peasants for help on the practical questions of applied entomology. The nature of the work would not permit the staff to leave the station to satisfy the demands of institutions or of individuals. This necessity was realised, and there arose the question of inviting an entomologist who would be able to help the population to control the insect pests, and who could make a survey of the pests of the province. Accordingly in 1914 an entomological bureau was established there.

According to the agreement of the Zemstvo of Poltava with the Poltava Agricultural Society, the experimental station offered its premises and its entomological laboratory to the bureau, which from the very beginning made the fullest possible survey of the pests and diseases of vegetation is the province. The Bureau organized for this purpose, first of all, an extensive system of correspondents, and by the end of 1914 the number of correspondents reached 600. The popular papers published were of service in the work of consultation and for the popularizing of entomology. These papers were of three kinds; (a) the type that informed the peasants regarding certain pests and rational means for destroying them. It also indicated the apparatus and materials used for destroying these pests and mentioned firm and warehouses where they could be obtained; (b) In the second type, the bureau showed the method of protecting particular cultivated plants from their pests, giving the same kind of information as the first type, but also summing up all the given facts about several pests of one plant; (c) The third type is the periodical pamphlets which describe seasonal measures for destroying the pests.

Kjazan Entomological Bureau:—

Established in 1915. Among the pests the bureau studied *Aporia crataegi* L., *Psylla mali* Ferst, *Anthonomus pomorum* L., *Phyllotretae*, *Euxoa segetum* Schiff. In 1915, the entomological bureau made observations on the pests of clover, namely *Apion*.

4. South Western Region:—

In this region there are two permanent entomological institutions: the entomological station for protecting plants in Kiev; the entomological bureau of the Zemsvo of Volyn.

Kiev entomological Station was instituted in 1904. (2).

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(1) Organized and conducted by the late N. Kurdjiemov, most brilliant of Russian entomologists.
(2) Under Professor V.P.Pospelov, at present Director of the Central Bureau of Entomology, Petrograd.

During the existence of this station, it has accomplished the following principal works:

1. The control of *Bothynoderes punctiventris* Germ (pest of sugar beet). (At the same time, observations were made on the chief features of the life of this pest).
3. The control of *Euxoa segetum* Schiff in beetroot plantations.
3. " " " *Oscinis frit* L.
4. " " " *Cecidomyia destructor* Say.
5. " " " *Phlyctaenodes strictacalis* on beetroot plantations.
6. " " " *Siphonophora pisi* Kaltenbach.
7. " " pests of gardens.
8. " " forest pests.

Also the station made many observations on a number of other insect pests, which greatly increased its knowledge of their life histories.

Special attention was paid by this station to the control of insect pests by the parasitic method, while from the very beginning, it was obliged to give attention to the insects that injured stored products.

In 1912, the station, with the financial support of the Department, organized the 3rd International Conference of Sprayers.

In Smela, also in the province of Kiev, there has existed since 1901 a *Myco-entomological experimental station*, supported by the All-Russian Sugar Planters Association, which is occupied in studying pests and diseases of sugar beet, and other cultivated plants involved in the beet culture; also of weeds, for it is on them that the pests and diseases of cultivated plants are usually developed.

The purpose of these observations was to discover preventive measures and means for destroying the insects and diseases.

Volyn Entomological Bureau:—

Established in 1913.

Unfortunately the war, especially in 1915 when one-third of the province was occupied by the enemy, absolutely prevented the development of the work of the Bureau. In spite of all these unfavourable conditions, the bureau in 1914 and 1915 made observations on quite a large number of pests of fruit and orchard plants; also on pests of hops, beetroot and other crops.

5. Southern Region:—

This region is provided with four entomological organization:—1. The Bio-entomological station in the Zemstvo of Bessarabia; 2. Entomological section of the Department of Agriculture in the Zemstvo of Ekaterinoslav; 3. Entomological organization in the Zemstvo of the Crimea; 4. Entomological Station of Kherson.

The oldest of these entomological organizations is that of the Crimea; then follows that of Kherson; after that, that of Bessarabia; and lastly that of Ekaterinoslav.

Entomological organization in the Crimea:—

The functions of the entomological bureau in the Crimea are performed by the local museum of Natural History which was established at the suggestion of the entomologist I. A. Mokzzhecky, who was invited to fill the post of economic entomologist soon after its establishment by the Zemstvo on June 10, 1893. The Chief reason for establishing this post was the appearance in the Crimea in 1891 of a new insect *Eurygaster maurus*, which was not then known. and which in 1892 destroyed about 60,000 acres of wheat in the district of Theodossia.

The duties of this entomologist are:

1. Observations on insect pests in places where they appear, and the organization of measures to destroy them.
2. The organization of observations on insect pests in their natural surroundings.
3. The organization of experments for testing one or other measure for the destruction of field and garden pests; the testing of different insecticides; and experiments for testing other methods of keeping plants healthy and destroying pests, such as fumigation, parasites, etc.
4. Consultation work, which consists of giving verbal or written advice to owners in reply to their questions concerning the destruction of insect pests.

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(1) At present in Poland.

5. The organization of courses, discussions, and lectures, on the subject of economic entomology.
6. Scientific literary work which consists of recording the information obtained on the biology of insects and of observations on their life history.
7. The care of the local Museum of Natural History.

The work of the economic entomologist relative to the finding of the best measures for the destruction of local insect pests, resulted in recognizing as the best, the chemical method, or spraying with poison those plants which serve as food for the pests. In 1894 the economic entomologists first made experiments by spraying orchard-gardens with a mixture of Paris green and lime; and of Bordeaux mixture and Paris green. In 1896, in co-operation with the Gardening Society, a booklet was published on the use of Paris green (this was republished several times). A large amount of Paris green with copper sulphate was obtained, and American sprayers were bought. In the spring of 1896 the method of spraying fruit trees with the mixture of copper sulphate and Paris green was used in many orchard-gardens, and it gradually spread throughout the whole of the Crimea.

Among other insecticides which were first used in the Crimea must be mentioned the so-called "gypsin" (lead arsenate), which was used under this name, thus replacing Paris green.

Also a great deal of attention was paid to the fumigation of plants with cyanide gas for killing the insects; attention was also paid to the parasitic method of destroying insect pests.

The results of the study of the insect pests were published in the yearly report of the work of the entomologist.

The work of the economic entomologist, which lasted 23 years, resulted in the publication of over 200 papers on these subjects.

Kherson Entomological organization:—

This organization ,represented by an economic entomologist from the very beginning of its existence, made systematic observations on the pests that appeared in the province, which were reported in the yearly "Review of the enemies of agriculture in the province of Khersonsk", by T. K. Pachovsky, the economic Entomologist.

A special characteristic of this organization which is closely connected with the museum of Natural History in the Zemstvo of Khersonsk, is the study of not only the injurious insects and animals but also of weeds, and the economic entomologist, (who is also the superintendent of the museum), has published many papers on this question. According to the yearly "Review ", the last few years can be considered to have been fortunate ones for, with the exception of *Cephus pygmaeus* which appears nearly every year in the province, other species of crop pests that are usually found in the province, have not been observed.

Among the pests that are usually found in the province are *Anisoplia austriaca* Herbst., *Euxoa segetum*, Schiff, *Adelphocoris lanceolatus* Goex, *Epicometis hirta* Roda, *Phytoptus piri* Sor. all of which appear in some places in considerable numbers.

Bio-entomological station in Bessarabia,(1) established in 1911:—

Among the insects and parasites found in the province of Bessarabia, the station made a particular study of the pests and diseases of vineyards, and among them special attention was paid to mildew and the means of controlling it.

Besides this, mention must be made of work on controlling the larvae of *Athalia spinarum* and the big experimental work relating to the control of *Lema melampa* L, and *Cheimatobia brumata* Lin.

For the widest possible diffusion of knowledge regarding measures for the destruction of garden pests among the population, the station devoted a considerable amount of attention to the work in demonstration gardens, in the gardening regions in the province of Bessarabia.

Ekaterinoslav Entomological Bureau:—

Established in 1914.

Among the field pests in the province of Ekaterinoslav, *Ozia (Tapinostola) musculola* Hübn, was of special importance owing to the harm done by it in 1910-1914 throughout nearly the whole of the province.

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(1) Now part of Roumania.

6. South Eastern Region:—

In this region there is only one entomological institution, namely, the Astrakhan Entomological Station.

The region of Astrakhan, where the cultivation of gardens, vineyards and orchards has been greatly developed, has always suffered greatly from many different pests. This loss attracted the attention of the Astrakhan Society of Gardening, and ever since the Society was founded, at its request entomological specialists were often sent to the province from the Ministry of Agriculture for the purpose of studying local insect pests, and finding the most rational means of destroying them. But usually the entomologists could not remain long in the province, consequently they could not devise efficient control methods for the agricultural pests, Therefore, in 1907, the Society asked the Department of Agriculture to establish a permanent Entomological Station in connection with the Society, which began to work systematically in January 1912. (1)

The first two years of the work of the station coincided with the appearance of hordes of *Phlyctaenodes sticticalis* and locusts. The station took an active part in destroying these insects,and began the application of the chemical method of spraying on a large scale. The work of the station during those two years was of a purely practical character, and very little time was left for making observations on other pests, or for getting acquainted with the general condition of the province. The personal staff performed this useful work in different districts of the province and by the end of the third year, observations were finished and the pests of the province were more or less known. Besides, the station had by this time become acquainted with the local conditions, and knew the proper measures for destroying the insects in every part of the province. The work of the station was mostly concentrated upon the pests that injure vineyards, orchards and gardens. At the same time some attention was paid to the pests found in fields. First of all were studied those pests which did considerable harm, but which were unknown in entomological literature. Such pests were: 1. Pests of mustard; 2. *Birton hirtarius;* 3. *Galerucella fenella* L, a pest of strawberries; 4. Caterpillars of *Talis quercella* Schiff, found in the steppes in the district of Zare.; and others.

7. Stavropol Entomological Bureau:—

The principal reason why the Stavropol Entomological Bureau was founded was the huge loss caused to the province of Stavropol by hordes of locusts, the chief of which were the *Dociostaurus maroccanus* and *Locusta migratoria.* The idea of establishing a permanent entomological station was first discussed at a meeting called for this purpose on the 18th October, 1910, in Stavropol, but no definite decision was then reached. But the question was discussed again, with the result that an entomological bureau was established in Stavropol in 1912 (2). The reason why an entomological bureau was established, (whose organization stood nearer to the field work) instead of a scientific experimental organization, such as an entomological station would have been was the desire to make the staff of the bureau take part in the work of destroying the pests, chiefly the locusts, for this work could be successful only when directed by persons fully competent for such a task. In fact the principal task of the staff of the bureau during the first two years of its existence was the organization and working out of measures for destroying the swarms of locusts.

In 1913 it became possible to make certain special observations. The entomologist of the bureau,B. P. Uvarov, finished the work on the morphology and taxonomy of two species of *Locusta* L. (3) The assistant entomologist, V. A. Glazonnoff, completed the study of the comparative anatomy of the larvae of *Cephus pygmaeus* L., and *Trachelus labidus* L.

The gathering of information about the local pests was considered very important by the bureau, and from the first year of its existence it made a full record of not only those pests which undoubtedly did harm in the province of Stavropol, but also of those which had not yet been for some reason, (for example, the insufficiency of observation owing to their small numbers) considered as serious pests in the Province, but which might be potential pests.

8. Turkestan Entomological Station:—

The most injurious agricultural pests in Turkestan is the Moroccan locusts, (*Dociostaurus maroccanus*), which owing to the failure of the mechanical measures used to destroy it, necessitated

(1) Under N. L. Sacharov.

(2) Under B. P. Uvarov, who remained there until 1915.

(3) Which resulted in a new theory of periodicity and migration of locusts (see Bulletin Entom. Research, London, XII, 1921).

in 1890 the calling of a conference of entomologists in order to find a more effective means of destroying it. There also arose the question of a permanent organization to take charge of those measures, and of a systematic study of locusts and other insect pests. As a result the local authorities conceived the idea of establishing an entomological station, which started its work in the spring of 1911. (1)

The programme of the work of the station may be outlines as follows:

The entomological station is an establishment of an applied character; it studies the locusts and the biology of other insect pestsof Turkestan, and also takes part both in organizing and in working out measures for destroying them, by means of directing and handling ,respectively, protective and destructive measures.

As the most important aim of this entomological station was the study and organization of measures to destroy the insect pests of Turkestan in general, the station made use of all its available scientific force for organizing rational measures of destroying the Moroccan and other locusts.

The station studied the local locusts, their breeding places, distribution throughout the region, time of their spring appearance, stages of larvae, their manner of life and habits, their natural enemies, laying of eggs, infection of the latter with parasites, etc. Owing to such detailed knowledge of local locusts ,it was possible to try new measures for their destruction with a greater confidence, and to organize measures that would come up to modern standards of scientific knowledge on this this subject.

The second in importance among the pests is the Codling moth, which does enormous harm to the increasing industry of orchard-gardening, and serious attention was paid by the station to this pest.

In addition the station studied other pests of gardens and vineyards, investigated their distribution in the region, and tested effective measures for destroying them.

The station also studied the pests found in fields and market gardens, and paid special attention to the pests of hops and beetroot which are the most valuable among the cultivated plants of the province.

The study of agricultural pests in the province of Turkestan shows that most of the pests found there are the same as those found in middle and southern Russia. One must, however, note the absence of *Phylloxera*, and of *Melolontha melolontha* L. in Turkestan which is replaced by *Polyphylla adspersa*, the destruction of which is even more difficult.

The insect pests found only in Turkestan, are the following: *Agelastica orientalis* Baly and *Pachydissus sartus* Sols, which do great harm chiefly among the forest trees used for building. Among the orchard-garden pests, the most serious one is the Codling moth which spoils and destroys many pears and apples. Quite as much harm is caused by *Grapholitha funebrana* and *Rhynchites auratus*. During the last few years the activity of the woolly apple aphis has also been noticed.

The results of the work of the station on the subject of insect pests have been recorded in a number of papers and memoirs.

RUSSIAN ENTOMOLOGY SINCE 1914.

Reference has already been made to the rapid development of applied entomology by the establishment of a large number of entomological stations throughout Russia from 1895 onward. Up to 1910 such stations had been established in four southern provinces, but in 1914 there were 21 stations. During the first years of the War the number of stations was increased, for the authorities saw the necessity of increasing the products of the farms, and to preserve them from severe outbreaks of insect pests. In Transcaucasia bureaus were established at Tiflis, Elisavetpol, Baku and Kutair, where an organization on a very extensive scale was established under the charge of B. P. Uvarov. Each bureau consisted of three sections, entomological, phytopathological and zoological (for the control of rodents.) The Tiflis bureau gave most attention to orchard pests, to moles, and the pests of tobacco and vineyards; besides,it accumulated much material and information on the insects of Transcaucasia. The

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(1) Under V. I. Plonikov, still in charge of the station.

bureaus at Elizavetpol and Baku concerned themselves chiefly with locust control.

During the same period (1914-1917), local organizations were formed at Rostov, Saratov, Vladikavkaz, Ekaterinode and in Siberia, while existing stations were enlarged.

After the Revolution of 1917, the stations in the outlying provinces which had proclaimed their independence, namely the Baltic States and the Caucasian republics, were cut off entirely from Russia proper. In most cases these provinces had a non-Russian population and the lot of the Russian specialists in the stations was not an easy one, for the new national authorities maintained an attitude of suspicion against them as Russian "oppressors", and required of them a knowledge of the native language. The lot of those entomologists, however, who remained in Russia proper was still worse, and the Red Terror, civil war, typhus and starvation have taken away many of them, including several leading specialists. Besides, the new, ignorant, often illiterate Bolshevik authorities at first paid little attention to the agricultural, being occupied with the political struggle. As a result, the entomologists, and for that matter the entire Russian educated classes, had to earn their living by making shoes, doing clerical work, or working on farms and at the docks. Even the few men who remained at the stations at their posts were obliged to grow vegetables to stave off starvation.

Under such conditions, where the large tracks of uncultivated land favoured the increase of pests, and when control measures were almost wholly neglected, the country during 1919-1921 was overrun with locusts, rodents and many other pests which appeared in enormous numbers in districts hitherto exempt from the attack. The losses were so great that the Soviet authorities began an enormous programme of entomological work to save the crops and the people, and stations were established in almost every province—often in their sub-divisions. But it was more easy to pull down than to build up. Qualified men could not be found at this time for the new posts. Instead, young men without any qualifications were placed at the stations, and the pests continued their ravages. However, it must be said that the money appropriated for the up-keep of the stations was totally inadequate on account of the great decrease in the value of paper money. Moreover, there was great difficulty in getting the money through the complicated and entangled systems of Soviet "red tape".

One excellent result was the recognition of the economic entomologists as useful members of the population, In point of comfortable living, however, they were not much better off than before: their anti-locust work had to be carried on with a miserably small amount of money which had to be extracted after the expenditure of much time from numberless ignorant authorities. In spite of the handicaps, many of the economic entomologists made good; they cleared vast tracts of Siberia and other provinces from locusts by the adoption of the poison bran bait on an enormous scale. Most of the unsuitable men gradually fell out and the position of the conomic entomologists was strengthened when the authorities began to see their value and realized that success did not depend upon mere numbers of stations and men but upon the quality of the men and adequate funds and materials.

With the deterioration of Soviet finances began a new movement—the reduction of the number of local stations, closing first of all those opened after the Revolution. Unfortunately some stations that had excellent staffs suffered much reduction, while others that were doing poor work were kept intact due

to "bluff". The reducing process is still in operation, and the future is full of uncertainty.

The purely scientific entomologists—members of museums, professors, specialists in Experiment Stations—have fared worse, since it was not easy to prove to ignorant authorities the necessity of pure research without immediate practical application. Accordingly the losses in pure entomology have been very heavy. Some were obliged to turn to economic work, where the pay was greater, but in spite of the very hard conditions of life, many have kept bravely at their posts. When it is realized that a university professor's salary is about L4. a month, while the cost of living is higher than it is in London, it is remarkable how these men were able to keep body and soul together, with miserable rations of food, and to prosecute their scientific studies, often in unheated buildings in winter without artificial light. An enormous number of unpublished manuscripts prepared by the museums and societies are ready for the printer, but no money is available.

The Russian scientific workers have shown a devotion akin to martyrdom; they did not abandon science when conditions of life became scarcely bearable, but science served them as a refuge from the grim realities of life.

MOST IMPORTANT RUSSIAN ENTOMOLOGICAL WORKS

I. Periodicals and serials.

1. *Horae Societatis Entomological Rossicae 1958-1919.* (Temporarily suspended owing to the lack of funds). Vols. I-XLI. Pretograd. Published by the Russ. Ent. Soc.
2. *Revue Russe d'Entomologie 1901-1922.* Vols. I-XVII. Petrograd. Published by the Russ. Ent. Soc.
3. *Messager Entomologique.* Vols. 1-11, 1913-1914. Kiev. Published by the Kiev Society of Friends of Nature.
4. *The Journal of Applied Entomology.* Vols. 1-II. 1917-1818. Kiev. Published by the Russian Association of Applied Entomologists.
5. *Entomological Messenger.* Kiev. (Contained only reviews of current Russian literature on applied entomology).
6. *Memoirs of the Bureau of Entomology.* Vols. I-XII. Petrograd . Published by the Bureau of Entomology of the Ministry of Agriculture (now Section of Applied Entomology of Agricultural Research Committee). Contains a most valuable series of monographs of very many important injurious insects; each monograph published as a separate part and there are about 10 parts in each volume.
7. *Reports of the Bureau of Applied Entomology.* Vols. I-II. 1921-1922. Petrograd. Published by the same institution and intended to include smaller papers, all the larger ones being published in the *Memoirs.*
8. Numerous reports of the local entomological institutions, proceedings of entomological and entomo-phytopathological conferences, etc.

II Handbooks and General Works.

1. N. A. Cholodkovsky. *A Course of Entomology, Theoretical and Applied.* St. Petersburg, 1912. 3rd edition. (An excellent general handbook.)
2. N. M. Kulagin. *Injurious Insects.* Moscow. (Three editions. Published 1904-1923. Contains extensive information on Russian insect pests.)
3. N. N. Bogdanov-Katkov. (Under his editorship, but by several authors). *Practical Entomology.* Petrograd. 1921-1923. (Published in parts by different authors; so far only four parts are out).
4. Köppen, Th. *Injurious Insects.* 3 vols. Petrograd. 1980. 1545 pp. (An enormous amount of information on Russian economic insects; still very valuable though out of date; out of print.)

5. K. E. Lindeman. *General Foundations of Entomology.* Petrograd. 1902. 628 pp.
6. B. P. Uvarov. *Agricultural Entomology; Insect Pests of Georgia and their control.* Tiflis, 1923. 234 pp.
7. V. I. Plotnikov. *Insects Injurious to Agriculture, Horticulture and Market-Gardening in Turkestan, with Indications as to their Control...* Tashkent.. Published by the Turkestan Entomological Station 1914. 216 pp.
8. David Sharp. *Insects,* 1910. (Translation by N. Kuznezov, of the well known book with many additions; much more complete and up-to-date than the original).
9. J. Porchinsky. *Insects Injurious to Fruit Gardens in the Crimea.* 1889.
10. A. F. Rudsky. *Insects Useful and Injurious to Fruit Trees.*

III. Books on Taxonomy.

1. G. G. Jacobson. *Beetles of Russia and of Western Europe.* 1905-1917. Petrograd. 1034 pp. 52 coloured plates. (A complete catalogue, with synonyms and distribution of the whole Palaearctic fauna. including China, Central Asia and Japan. Published in 11 parts—one more remains ,but publication temporarily suspended since the publishers' firm has been nationalised; the manuscript is complete, with the author, who is a member of the staff of Zool. Museum of the Academy of Sciences, Petrograd.)
2. G. G. Jacobson and V. L. Bianchi. *Orthoptera and Pseudoneuroptera of the Russian Empire.* Petrograd. 1905. 952 pp. 25 coloured plates. (A complete monograph of the orders indicated for the whole Palaearctic region; the work is based on Tümpel's *Orthoptera of Middle Europe,* but contains a great amount of material not in the original. By far the best book or Palaerarctic Orthoptera existing in any language).
3. N. M. Romanoff. *Mémoires sur les Lépidoptères.* Petrograd. 1884- 1901. 9 vols. in 4; Contains a large series of most important monographs and papers by the best lepidopterists of the time).
4. Several large German books on Lepidoptera, (Lampert, Berge, Hoffman) have been translated and published, partly with important supplements on Russian fauna. Books by J. Fabre, Lubbock and many others also exist in very good Russian editions.

IV. Miscellaneous publications:

1. Reports and other publications of local stations, too numerous to mention.
2. Papers in general agricultural press.
3. Separate publications by the Department of Agriculture, Department of Forestry, etc.

Almost all Russian economic publications since 1913 are regularly reviewed in the *Review of Applied Entomology.*

DR CHARLES EUSEBE DIONNE, NATURALIST. 1845-1925

By Dr. A. Dery and S. Matte of the Provancher Society of Natural History, Quebec.

In the death of C. E. Dionne, which occurred on January 25, 1925, the world of natural science lost one of its finest personalities. Almost unknown, and humble as all true scientists are, he progressed and became, by dint of effort, perseverance and courage, one of the leading ornithologists of his country.

His death is a severe loss to scientific societies and to sportsmen, but especially to Laval University, where his place will be difficult to fill.

Charles Eusebe Dionne, son of Pascal Eusebe Dionne and Emilie (Lavoie) Dionne, was born on July 11, 1845, at St. Denis, Kamouraska County, Quebec. His father was a farmer of limited means.

As a boy he attended, not too regularly, the parochial school at St. Denis, until he reached the age of 11. When very young, he loved to wander through woods and fields and along the shores; his interest in things relating to natural history, such as plants, insects, and birds, was being developed through contact with nature herself.

He was especially attracted by groves and by a certain swamp behind his father's house, in which he used to see the Maryland Yellow-throat, a bird which particularly attracted his attention as a beginner.

When he left school, he remained on the paternal farm till he reached the age of 15. A little later he went to school again for two different periods, totalling thirteen months. The teacher, Mr. Guillaume Robichaud, taught a special class of two pupils, to which, as a favor, young Dionne was admitted, but as a listener only, not being given the right to put any questions. Soon, however, the teacher noticed his application as well as his eager desire for learning, so that he treated him just as he did the other pupils. His progress was so remarkable that one day Mr. Robichaud, referring to him, said, "See young Dionne; he has learned in thirteen months what most of the others require four years to learn".

This special class furnished him an opportunity of seeing for the first time a text-book on natural history. Having seen the coveted book on a shelf and being too timid to ask for it, he had recourse to a stratagem to snatch it, study it, and replace it as it was. Shortly afterward, the teacher, having discovered his doings, amicably reproached him for his timidity and placed the book at his disposal. Dionne read and reread the volume and copied all the figures therefrom.

One of his brothers was an employee at the Quebec Seminary. Charles decided to join him and on January 19, 1865, he was appointed a campus employee at a salary of $4.00 per month plus room and board with the students. But after the fire of March, 1865, he was given work in the kitchen.

There was then a museum at Laval University (closely associated with the Seminary), but rigid rules forbade all employees to enter it. Young Dionne did not even know that it existed.

In September 1866 he was appointed, apparitor in the Faculty of Law of Laval University with free access to the library. In such proximity to the museum Dionne became aware of its existence. He also began his botanical studies by means of books from the library. His first author was Buffon. The following year saw the beginning of his collection of birds. His collection of insects was also commenced about that time, with the encouragement and advice of Mgr Hamel.

The only time which he could devote to his study and the work of forming his collections was that after the close of his day's work as an employee and what he could spare at lunch time and he almost had to hide to use even these hours in his favorite way for fear of ridicule from his fellows-employees.

The Rector, Mgr Hamel, took much interest in his studies and would periodically come and chat with him, observe his progrees and encourage him. Abbé Laverdière, just before be died, strongly recommended that the authorities of the Seminary should held young Dionne and facilitate his studies by giving him the necessary freedom of action.

About 1867, he attended an evening course of in truction given by Mr. Cloutier at the old Normal School. He found it difficult at first to obtain permission, as this class ended too late in the evening to allow him to return to the the Seminary building before the closing of the doors at 8.45 p.m. Far from being discouraged by the Proctor's refusals he submitted his request to the Rector, Abbé (later Cardinal) Taschereau, who not only granted his wish, but gave orders that a door should be left open every night until his return. The following year he was able to continue his evening course at the Brother's Academy, under the direction of Abbé (later Mgr) Gauvreau.

On May 6, 1876, he married Marie Emilie Pelletier.

In 1882 he was appointed Curator of the Museum of Laval University At that date the Museum contained but a small fraction of its present wealth, and most of the specimens in it were neither named nor classified . Mr. Dionne' first ambition was to establish order. Single-h nded, he accomplished this task so well that it will always remain the most worthy monument to this memory; a monument full of precious lessons for the information of generations to come. The board of directors of that period had truly made a happy choice in appointing Mr. Dionne as Curator.

All of Mr. Dionne's outings were devoted to collecting; he would visit the woods in the vicinity of Quebec, such as those at Sillery, Charlesbourg, and around Chateau Bigot, as well as the shores at St. Denis, Rivière Ouelle, and Chateau Richer. Unfortunately, the time at his disposal was very limited and holidays were few. A determination such as his, coupled with a decided love of his work, alone explains his persistance in following his favorite studies notwithstanding the difficulties imposed by chance and circumstances. "In spite of that", he would say, a short time before his death, "if I were to start all over again, and if I saw in advance all the obstacles which I had to conquer. I would not hesitate to choose the same path".

In 1889 he collected at St. Denis specimens of the Acadian Sharp-tailed Sparrow (*Passerherbulus nelsoni subvirgatus*), which had recently been described by Dr. Jonathan Dwight, Jr., of New York, from specimens obtained in the Maritime Provinces. Soon afterward Mr. Dionne published his records of this bird in his *Catalogue annoté des oiseaux de la Province de Québec.* Some time later Dr. Dwight, who had read this publication, sought for the Sparrow in question in various marshes along the St. Lawrence (but not at St. Denis) but without success. So he went incognito to see Mr. Dionne and questioned him concerning the bird. This disclosed his identity, since no one but Dr. Dwight could put such questions. Mr. Dionne's specimens were therefore shown and

his identification confirmed. Dr. Dwight has held him in high esteem ever since.

Mr. Dionne learned taxidermy from books, but, as a result of his constant striving for improvement and his observation of nature itself, he found methods that were often more efficient and practical than those previously employed.

In spite of a great loss sustained in a fire in 1917, Mr. Dionne's private collections are very valuable. Space does not permit of mentioning them in detail here, but they include, many birds and mammals, butterflies and other insects, as well as a herbarium.

Mr. Dionne's main travels are the following:

In 1882 he was invited to take part in an expedition to the lower St-Lawrence on board the Druid in company with Mr. J. U. Gregory, an agent for the Canadian Department of Marine. The object of the excursion was to make certain studies and observations on game.

He went in Chicago in 1893 and attended the opening of the Field Museum. In 1900 he visited the American Museum of Natural History, at New York. During a trip to Europe in 1912 he visited the Jardin des Plantes, the Musée d'Histoire Naturelle and the Musée d'Anatomie, in Paris, and the British Museum, in London.

Besides various scattered notes and articles in scientific periodicals he published the following works; Les oiseaux du Canada, Catalogue Annoté des Oiseaux de la Province de Québec, Les Mammifères de la Province de Québec, Les Oiseaux de la Province de Québec, Les Araignées. All of these works are recognized authorities in their respective fields.

A Master of Arts, he was made a Doctor of Science a few days before his death, at the completion of sixty years spent by him in the service of Laval University. He was a member of the National Geographic Society and had been a fellow of the American Ornithologists' Union since 1893. He was one of the founders of the Provancher Society of Natural History.

His field of action was not limited to the fauna of his own country; in fact, he made, with scientists of all countries, thousands of exchanges of specimens of insects, bird skins, and plants, thus helping greatly to make our national treasures of natural history known in foreign lands.

An amateur inquiring for information or bringing specimens for his inspection was sure to receive every possible assistance, given in the kindest and most gracious manner. In this excellent fashion Mr. Dionne popularized natural history among the people of his province.

Dr. C. E. Dionne was assuredly not a closet-naturalist and his knowledge was not merely book knowledge, for he studied from nature's great open book.

THE OUTBREAK OF THE GIPSY MOTH IN SOUTHERN QUEBEC

L. S. McLaine

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So much has been written and said about the Gipsy moth situation on the North American continent, much of which is undoubtedly familiar to the members of this Society, that it will be necessary only to review the history of this insect in the briefest manner. It was in the early sixties of the last century, that a French scientist, living in the vicinity of Boston, imported some egg clusters of the Gipsy moth from Europe with the intent of crossing this insect with native silkworms. Some of the material escaped, and although the matter was brought to the attention of entomologists and others through the medium of the scientific press, no action was taken to investigate the situation. More than twenty years were required for the insect to become established and for the caterpillars to become so abundant as to receive public notice. Control measures were inaugurated and by about 1900, the infestation had been so reduced that the officials in charge were in hopes that the eradication of the pest was not impossible. In spite of the vigorous protests of the entomologists, who were anxious for the control work to be carried on for a few more years in an endeavor to eliminate the insect, the state legislature refused to appropriate any further funds and the work was closed down. By 1905 the insect had increased to such an extent that it was imperative to recommence control operations in the field if the forest, shade and fruit tress were to be saved. A field survey of the infested territory showed that the insect had spread over twenty-five hundred square miles, and it was then realized that there was no hope of exterminating the gipsy moth from Massachusetts.

From that time the insect has been gradually spreading in all directions, but particularly in a north easterly direction, like an ever encroaching sea, in spite of the millions of dollars that have been spent by the federal, state and civic authorities as well as private individuals in an effort to stem the tide.

Canada has been keeping a close watch of the situation, and entomologists realized that it was only a question of time before the Dominion would be invaded. There appeared to be two vulnerable points in Canada where an infestation of the gipsy moth, due to natural spread from the United States, was likely to occur, one was in New Brunswick through the state of Maine, and the second, in the eastern townships of Quebec through New Hampshire or Vermont.

In the fall of 1922 an international conference was held at Albany, New York to discuss the gipsy moth situation. Officials actively engaged in the gipsy moth control work and others in adjoining states who were intensely interested in the problem, as the pest was gradually approaching their territory, decided that it was necessary to review the entire situation and try to work out

some definite scheme of control. Furthermore, it was appreciated, that with the increase in the size of the infested territory, there was a corresponding increase in the amount of money necessary for control work, and it would not be long before sufficient money would not be appropriated for this work. As a result of the conference , a barrier zone was to be established twenty five miles in width and extending from the international border to Long Island Sound. All territory in this area was to be kept free from the gipsy moth.

Canada was naturally very interested in this policy, especially as in 1912 the nearest colony of the gipsy moth was only ten miles from the Quebec border. During the summer of that year two Federal scouts made a hurried survey of the eastern townships, and as a result of the conference held in the fall of that same year, a more extensive scout of this same area was made the following summer. In the fall of 1923, just as the scouting work in Quebec was being completed, the most severe outbreak of the gipsy moth ever found in New England, was discovered at Alburgh, Vermont, within one half mile of the Quebec border. Scouting operations were immediately renewed in Quebec, particular attention being paid to the territory immediately north of the Alburgh outbreak, in the seigneurie of Foucault, but with no result.

Plans were however, instituted to carry out intensive scouting in southern Quebec in 1924. The necessity of this work being emphasized by the discovery of a number of outbreaks in the so called "Barrier Zone" in New York state. The Province of Quebec became actively interested in the problem, as an outbreak of the gipsy moth in the forest areas in Quebec, where artificial control such as spraying would be out of the question, would prove to be a very serious matter. Special appropriations for this work were made by both the Federal Department of Agriculture and the Quebec Department of Lands and Forests. The field work started in July 1924, and approximately thirty-six inspectors were employed from that time until late in November. The territory examined extended from Chateauguay county on the west to Compton county on the east, and to about thirty miles north of the international boundary. This area was divided into eight districts, and a foreman and three scouts were placed in each district.

On July 29th the first record of the gipsy moth in Canada was established by the discovery of a single egg cluster, near the village of Beebe, in Stantead county. This cluster, after careful examination was found to be infertile. Five weeks later a severe isolated infestation was discovered on the Belle Vallée road, Lacolle township, St. Johns county. It is interesting to note in this connection that the Belle Vallée infestation was found on the next road west, to where the work stopped the previous season.

Intensive scouting in the immediate vicinity of the outbreak, shows it to be confined to four farms on both sides of the road and covering approximately one third of a square mile. Control work consisting of creosoting the egg clusters was started soon after the discovery of the infestation and a total of 2,694

were so treated. About seven hundred of these were found on an old willow tree, and over a thousand in a stone wall adjoining it, the balance were scattered through adjacent orchards, on farm buildings, fences, etc. In addition old apple trees full of cavities likely to contain egg masses were cut down and burnt, and in others the cavities were filled, brush was cut and burnt. Extensive "clean up" work will be carried on in 1925, consisting of the thorough rescouting of the entire district, spraying the whole area with arsenate of lead, banding and tanglefooting of trees in the immediate vicinity of the outbreak, and the burning over of the stone walls at the time the caterpillars normally hatch.

It is the intention of both the Federal and Provincial Departments to exert every effort possible to eradicate the gipsy moth from Canada. In addition to "cleaning up" the Belle Vallée infestation plans are under way to carry on extensive scouting in all territory south of the St. Lawrence river. The wisdom of adopting this policy can not be over-estimated in view of the previous history of this insect. The federal appropriation in the United States for control work amounts to seven hundred and fifty thousand dollars a year, and fully as much if not more, is spent annually by the various state governments and civic authorities.

A severe outbreak of the gipsy moth was discovered in New Jersey a few years ago; during the first season over three million egg clusters were found. As the result of a very vigorous campaign by both the federal and state authorities, it appears as if the pest will be eradicated from that state. Numerous other outbreaks have occured in different parts of the United States but all of these have received prompt attention, with the result that the insect has been exterminated in those localities.

Experiments conducted on the effect of low temperatures on exposed egg clusters, gave us hope that the gipsy moth would not prove to be a menace under Canadian conditions, but the situation at Belle Vallée has demonstrated that under some conditions at least, an outbreak of this insect can not be viewed without alarm.

In an endeavor to prevent the spread of the insect in the egg stage, an embargo has been placed on southern Quebec, prohibiting the movement of Christmas trees and greens from some areas, and restricting it from others. The territory involved is one in which under normal conditions, large quantities of Christmas trees are cut for both the local and export trade. Unfortunately it is not feasible to examine these trees in quantity for freedom from infestation, consequently it was necessary to pass this regulation. It is to be regretted that it may prove a hardship in certain cases, but it is for the benefit of the country at large and it is the country and not the individual that must be given the first consideration.

OAT SMUT CONTROL IN 1924.

By B. T. Dickson.

Experiments were continued during the season of 1924 at Macdonald College using Liberty oats and both oat smuts. The grain was artificially inoculated as in previous years (1, 2) and treatments were carried out as before.

The grain was treated and sown on May 28th and 29th when the soil moisture content was 15 per cent. Except for a shower during the night of June 2nd, dry hot weather held from the date of seeding for about three weeks. The plants emerged on June 6th—10th, but field germination was considerably reduced by the attacks of a Thysanuran which destroyed the embryo completely. Sparrows also were a constant source of trouble. Yield studies were thus out of the question and this was further the fact because of very wet harvest weather.

Counts by heads were actually made of every plant which came to maturity The plots were replicated three times and each plot consisted of three rod rows.

The following summarizes the treatment and counts.

It will be noticed that dust treatments were best for the season as far as smut control is concerned, the results being:

Oat Smut control counts.—1924.

—	Rep. 1		Rep. 2		Rep. 3		Totals		
TREATMENT.	H.	D.	H.	D.	H.	D.	H.	D.	% Smut.
Check	376	493	415	581	429	678	1220	1752	5.84
Semesan Dust	582	53	724	50	868	45	2174	148	6.0
Nickel hydrate (calc. ppt. (D)	1109	21	819	23	997	26	2925	70	2.5
Nickel sulphide	985	3	698	12	918	7	2601	22	.8
CuCO3 (N)	892	23	657	10	852	19	2401	52	2.1
DuPont 13	478	264	612	327	754	435	1844	1026	35.7
NiCO3 (D)	623	37	851	39	881	43	2355	121	4.8
NiCO3 (H. F.G.)	651	10	872	13	894	18	2417	41	1.66
Nickel hydrate Caustic ppt. (D)	766	15	784	17	937	9	2328	41	1.7
Check	429	391	486	697	508	681	1423	1769	55.4
Sem. soak	926	77	874	64	1107	57	2907	198	6.4
Usp. soak	1050	44	831	38	1349	32	3230	114	3.4
Usp. dip	699	130	629	141	708	137	2036	308	12.6
Sem. Dip	578	298	643	183	684	169	1905	650	25.4
Check	566	742	317	484	690	1000	1573	2226	58.6
Form. 20 mins. then dry	673	197	605	126	628	145	1906	468	19.7
Presoak * form	675	10	873	34	829	37	2377	81	3.3
Form. * milk of lime	783	124	814	157	796	151	2393	432	15.3
Check	336	528	418	609	544	815	1298	1952	60.0
Usp. presoak * soak	812	135	896	192	923	263	2631	590	18.3
Usp. presoak * dip	670	271	718	241	741	244	2129	702	24.8
Sem. presaok * soak	845	263	816	234	1255	330	2916	827	22.1
Sem. presoak * dip	609	251	582	283	793	254	1984	788	28.4
Sod. fluoride (0.5%) for 20 min.	307	257	362	281	......	......	669	538	44.5
Presoak Sod. fluoride	563	241	624	189	......	......	1187	430	36.5
Check	456	623	410	675	598	827	1464	2135	59.3

It will be noticed that dust treatments were best for the season as far as smut control is concerned, the results being:

Nickel sulphide 0.8% smut.
Nickel carbonate (H. F. G.) 1.66%
Nickel hydrate (by caustic pptn.) 1.7%
Copper carbonate 2.1%
Nickel hydrate (by lime pptn.) 2.5%

The checks (inoculated with both smuts but untreated) varied in smut count from 55.4 to 60 percent. It is thus obvious that with hull-less oats nickel salt dusts were very efficacious. The nickel dusts were placed at my disposal by Mr. Geo. Sanders of the Deloro Chemical Company, and were used at the rate of 2 ozs. per bushel of grain.

1. Dickson, B.T., R. Summberby and J. G. Coulson. Experiments in the control of oat smut. Quebec Soc. Prot. Plants Rept. 15: 102-105, 1923.

2. Dickson, B.T. Oat smut control experiments in 1923. Quebec Society Prot. Plants Rept. 16: 77-79, 1924.

MOSAIC OF RHUBARB.

By B. T. Dickson.

In Ju'y 1922 the writer observed three rhubarb plants in a market garden patch near Montreal, which appeared to be mosaic diseased. The plants were dwarfed sufficiently to be noticeable and were definitely paler in general color. The leaf blades were mottled and somewhat savoyed intervenally. Discolored longitudinal areas on the petioles were especially prominent in the reddest plant.

In the spring of 1923 the number of diseased plants had increased to eight and the newly diseased plants were alongside those found in 1922. The latter were still further dwarfed, were more mottled and the general chlorophyll content more reduced.

In the spring of 1924 there was a further increase in diseased plants and accentuation of symptoms of previously noted cases. This year aphids were plentiful on the rhubarb.

Mr. Vanterpool inspected the patch early this season (1925) and found 60% of the plants infected. Dwarfing and chlorosis were very marked. Many leaves were pale green with a few dark green patches here and there on the leaf blade (fig. 1). Inspection for Rumex spp. with mosaic in the vicinity has been negative in result.

Attempts to inoculate healthy rhubarb with the juice from diseased plants either by rubbing or by petiole injection have so far failed. It has not yet been possible to transfer aphids successfully.

Nevertheless I am quite certain that these *Rheum rhaponticum* plants have mosaic and this brief account is given that others interested may be on the watch for similar developments.

THE CRANBERRY ROOTWORM BEETLE (Rhabdopterus picipes Oliv.)

By C. E. Petch,

Dominion Entomological Laboratory, Hemmingford, Que.

Introduction.—This insect has been collected in the Provinces of Ontario and Quebec, at least, as early as 1896, but remained unrecorded as a past in Canada until 1924. My attention was directed to it on apple trees at Mr. J. Normandin's, Rougemont, Que., where it injured the foliage and fruit. Adult specimens were forwarded to Mr. Arthur Gibson, Dominion Entomologist, and he informed me that they had been determined as *Rhabdopterus picipes* Oliv.

Olivier first described the species in 1808 and placed it in the genus *Colaspis*. Say described it in 1824 under the name *Colaspis pretexta*. In 1859, (1) LeConte edited Say's writings and made a note under *C. pretexta* that it was the same as *Colaspis picipes* Oliv. It is recorded as *Eumolpus metalicus* Koch in Melsheimer's catalogue and it is placed in Dejean's catalogue in *Chalcophana*, a genus of which LeConte had never seen any description up to 1859. In 1892, Horn (2) transferred *picipes* from *Colaspis* to *Rhabdopterus*, a genus erected by Lefebvre in 1885.

This insect and *Tymnes metasternalis* resemble each other very closely and it is difficult to separate them, but in *R. picipes*, the thoracic lobes are absent behind the eyes, the thorax is more sparsely punctured and the metasternum smooth. Horn considers the name *picipes* as misleading, as Olivier's figure shows the insect to have pale legs.

Distribution

The insect is widely distributed throughout the United States and the provinces of Ontario and Quebec in Canada. The following States are cited in the literature read,—Indiana, Utah, Nebraska, Illinois, Dakota, south-western Texas, Florida, Delaware, Pennsylvania, New Jersey, North Carolina, New York and Massachusetts. There are twenty-nine specimens in the Canadian National Collection, listed as follows,—Trenton, Ont., 3 VII. 1910, (Evans); Western Ontario, (Evans) 3 sp.; Eastern Ontario (Evans) 3 sp.: Prince Edward Co., Ont., 1. VII. 96, (Evans); Ottawa, Ont., 14. VIII, (Harrington) 4 sp.; Ottawa, Ont., 20. VI, (Harrington); Casselman, Ont., 21. VI. (Harrington): Ottawa, Ont., 2. VIII, (Harrington—); Montreal, Que., 26, VI. 1898, (Evans) 2 sp.; Hull, Que., 20. VII, (Harrington); Rougemont, Que., 12. VII. 1924 (Petch) 5 sp.; Alleghany, Penn., 2 sp., Iowa: Unlabelled 3 sp. In Chagnon's list of Quebec Coleoptera it is listed as follows,—Rouville Co., VII, (Chagnon); Montreal and Jesus Isl., VII (Chagnon); Vaudreuil, Co., VII, (Chagnon.)

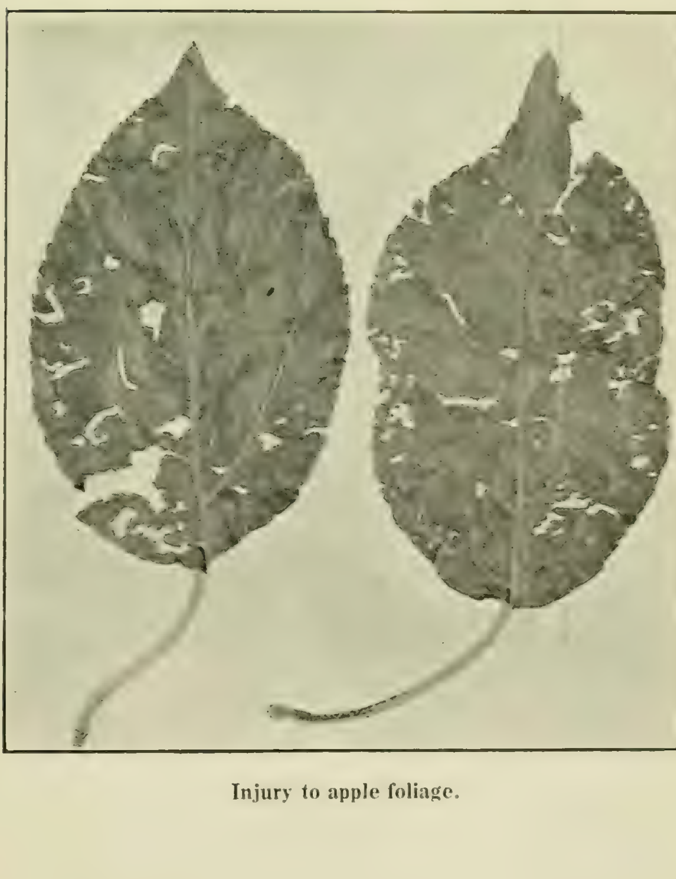
Food plants

The larva has been recorded only from the roots of cranberry but the beetle from quite a few plants. The recorded plants from the United States. are,—myrtle, basswood, grape, foliage and fruit of cranberry, wild grape, inkberry, blueberry, wild strawberry, dock, and fruit of the apple. In Canada it has been collected from alder by Harrington, basswood by Chagnon and apple foliage and fruit by the writer.

Character and extent of Injury

The larvae injure the plants mostly by completely devouring the fibrous roots of cranberry, but, as a rule, only the bark is eaten from the large and se-

Crankerry rootworm Beetle
(R. picipes)—4



Injury to apple foliage.

PLATE II.

Injury to apples

condary roots. The vines which suffer most are those growing on sandy lands. When root feeding is severe, the vines show signs of weakening in the early fall. The leaves dry out, turn red or brown, and the following spring only the dead uprights and runners, bare of green foliage, remain. The feeding on the foliage and fruit of the cranberry is negligible. Scammell (10) found in every instance where the Fulgorid, *Amphiscepa bivittata* Say, was abundant that the vines were in an unthrifty condition, due primarily to other causes, such as attacks from the larvae of the Cranberry Rootworm beetle. Sawyer, (12) (1920) found apples in an orchard near Sodus, N. Y., injured in a very peculiar manner by the adults of *R. picipes*. This is the first record of apples being injured which the author has found. The beetles confined their attack to the fruit, especially Grimes' Golden. About 75 per cent of the apples were injured. Ross, (7) (1916) published a photograph of a peculiar type of injury on Rhode Island Greening apples from the Niagara district. He remarked: "The apples were marked here and there with calloused blemishes, which varied in shape from dots to long, irregular, serpentine areas." Ross forwarded the specimens to Professors Caesar and Parrott, but they were unable to diagnose the trouble. Professor Parrott replied in part as follows: "During the past year we have discovered such injury upon apples, and specimens of peaches have been forwarded to us injured in a manner quite similar. I spoke to Mr. Knight of Cornell University regarding the damage and he intimates that such injuries may attend the work of red bugs". However, basing a decision on the similarity in design of the injury as shown in Ross's photograph in comparison with that found by Sawyer at Sodus, N. Y., in 1920, and by the writer at Rougemont Que., in 1924, it seems very probable that the injury was the work of the Cranberry Beetle. The author's attention was called to a peculiar injury to apples in an orchard near Rougemont, Que., on July 12, 1924. The orchard contained about 2,000 trees, mostly of the Duchess variety and the land was in sod. The injury was very extensive and was present on 50 per cent of the fruit and a large proportion of the leaves. Shallow, irregular channels were eaten out of the surface of the fruits, which sometimes comprise most of the apple (see fig. 1). The leaves are also attacked and portions of them are eaten as illustrated in figure 2. The immediate flora did not indicate the origin of the outbreak but it is probable the beetles migrated from the boggy areas on the top of the mountain, directly behind this orchard.

Description of stages

The beetles (fig. 3) are brown, bronzed and shining with the margins of the wing covers greenish bronzed. The legs and antennae are reddish-yellow and the under surface of the body greenish. They are three-sixteenths of an inch, or slightly longer, and about one-half as wide. The following description of the adult is taken from Blatchley (3) and of the other stages from Scammell (10).

The Adult. — Oblong-oval, convex. Brown, bronzed, strongly shining, the elytral margins often greenish-bronzed; antennae and legs reddish-yellow, the outer joints of former often dusky; under surface of body greenish, abdomen brown, its tip paler. Head coarsely and sparsely punctate, clypeus more closely punctate. Thorax nearly twice as wide as long, narrowed in front, sides strongly curved, hind angles prominent; disk rather sparsely and finely punctate. Elytra coarsely but not closely punctate, the punctures irregular on the disk, a line representing the third interval smooth. Lenght 4-5 mm.

The Egg.--The eggs of the Cranberry Rootworm measure 0.67 mm. in length by 0.30 mm, in width. In shape they are regularly elongate, elliptical. When first deposited, they are dirty-white in color, later becoming uniformly yellow. The shell is smooth and glistening, and sufficiently transparent to reveal the larval outline before hatching.

The larva.--The full grown larva measures from 7-9 mm. Normally, it lies in a curved position so that its full length is seldom revealed. Its color is whitish with head light brown and thoracic shield of very pale yellowish-brown. Tips of mandibles black, shading off to light brown at the base. Labrum and clypeus brown. A row of brownish spines, the ambulatory setae, on each ventral abdominal segment projects obliquely backward. Setae long. Legs slender and small.

The Pupa.—The pupa is slightly shorter than the extended larva, whitish in color. Spines on the head and thorax are longer and stouter than those in the larval stage, The middle and posterior femora are each provided with one curved spine and two straight, more slender spines; two flattened hook-like spines, curving outward, are found at the posterior end of the abdomen.

Life history and habits

According to Scammell,the appearance of the beetles is dependent upon the withdrawal of the winter flood from the bog. When distrubed, they fly short distances seldom more than three or four feet. The eggs are found in clusters or singly ,but mostly the former, just below the surface of the soil usually. The egg period varies from 6 to 11 days. The larvae feed during the summer and late fall and commence to feed again in the spring soon after the water recedes. The larval period lasts ten months and some larvae may spend another year in the bog. The average duration of the pupal stage is 14½ days.

Control

Scammell (6) says an arsenical added to the customary Bordeaux/and resin-fish oil soap is of value in killing the beetles on cranberry. Arsenate of lead, 1½ pounds to 50 gallons of water, has been recommended for cranberry but two applications should be made.

Franklin (8) states, after spraying cranberries with 2¼ pounds lead arsenate and 1½ teaspoondulls white arsenic to 40 gallons of water dead rootworm beetles were found in large numbers under the vines and only a few were crawling about.

Acording to Sawyer, (12) attemps to kill the beetles on apples by spraying with arsenate of lead were unsuccessful. Lead arsenate (powdered), 5 pounds, in 100 gallons summer strength lime-sulphur, was applied with great thoroughness without either killing the beetles or driving them away.

In a previous article, (13), I stated that the trees at Rougemont had been sprayed three times with Bordeaux mixture (4-4-40) and powdered lead arsenate, 1½ pounds to 40 gallons, before the infestation was examined on July 12. They were sprayed a fourth time on July 14 with the mixture just mentioned. The trees were examined five days later but the beetles were still present in large numbers. Apparently, the ordinary sprays are of little or no value in its control on apple. These sprays will have to be improved or other methods, devised, if the insect is to be controlled. Should this insect spread and establish itself in this province, it will cause very serious losses to our orchardists.

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TWO IMPORTANT INSECT ENEMIES OF THE MAPLE

By C. B. Hutchings

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The maple has been associated with Canada from the earliest of records. It thrives luxuriently in our forests and parks everywhere, and is planted more extensively in Eastern Canada for its shade, beauty and ornamentation than any other tree. The maple is not only one of the best Canadian hardwoods in point of importance, but its sap is used commercially in the manufacture of sugar and syrup, providing a substantial revenue of several million dollars annually, as the following figures will show:—

1924....	Sugar 9,385,415 lbs at 20.3c.........	$1,907,599
	Syrup 1,970,696 gals. at 20.72........	4,083,542
		$5,991,141 *

To obtain these products it was necessary to tap over 22,600,000 trees. Besides its many enemies of fire, fungi, wind and animals there are no less than over one hundred insects which infest the maple. They attack different parts of the tree: some of these bore into the wood, some tunnel the bark, others girdle the twigs and destroy the leaves. Not infrequently the injury is severe enough to kill the tree. I am going now to refer, specially, to two species which are considered as very serious enemies:

1. The Sugar Maple Borer, *Glycobius speciosus* Say.
2. The Maple Leaf Cutter, *Paraclementia acerifoliella* Fitch.

The Sugar Maple Borer

The first mentioned may be said to be one of the worst insect enemies that attack the maple. The injury produced by it takes the form of girdling of the trunk which may bring about the death of the tree in some instances. During the past summer I visited a number of sugar maple bushes in Ontario and Quebec and without any exception the work of the borer was evident in every one. In some cases as high as 60% of the trees showed infestation: some of these trees were dead and others in a poor and dying condition.

Adult

The adult of the maple borer is a Cerambycid beetle about one inch long and of a particular striking appearance. The body is black with several decided bright yellow bands on the wing covers, one forming the letter W very distinctly.

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* Dom. Bur. of Statistics, Bull. Agr. Stat. Vol. 17, p. 244, 1924.

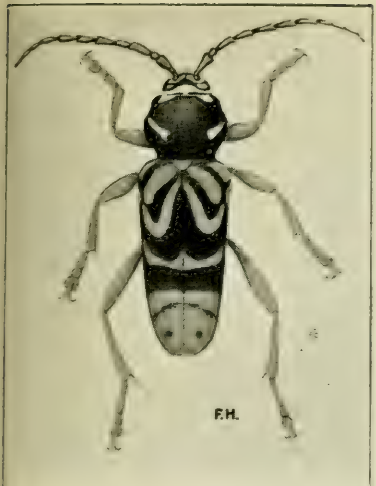


Fig. 1.—GLYCOBIUS SPECIOSUS Say adult enlarged about 1½ times. (Original).

Fig. 3.—PARACLEMENTIA ACERIFOLIELLA Fitch adult enlarged about 15 times. (Original).

Fig. 4.—Leaf of Sugar Maple showing work of Maple Leaf Cutter. (Original).

Fig. 2.—Maple Tree trunks injured by Sugar Maple Borer. On Left. Injury 10 ft up. Centre. Injury near base. Right. Bulging Scars, induced by larval work beneath. (Original).

Life-History and Injury

The beetle lays its eggs in the latter part of July and in August on the trunks of healthy trees. The young grubs work their way into the bark and spend the winter there. Next spring mining operations are carried on extensively in the bark in such a manner as often to completely girdle the tree. The bark above the tunnels becomes detached and drops off exposing the tunnel scars beneath. If complete girdling does not take place the tree will withstand the attack and heal the wound over with a thick callous; but where several larvæ are working together in the same area, the tunnels are apt to intersect and girdling will occur and the tree succumb. The mines very often measure over two feet in length and may be three-quarters of an inch wide at their further end.

Control

As to control, one of the best methods to be recommended is cutting out the very young larvæ before they get down into the bark. This has been tried with success. As the beetles are sun-loving, it is likely the cultivation of a heavy undergrowth will check them from laying, at least, on the lower parts of the trunk, which is a favourite place for deposition. At Ironsides, Que., a large sugar bush which I had the privilege of inspecting was covered with a heavy undergrowth and I attributed the low infestation of *Glycobius* (about 3 to 5%) as likely due to this factor, since no control measures whatever were practised.

The Maple Leaf Cutter

I should like now to refer for a few minutes to the Maple Leaf Cutter. As the name implies, it is a leaf feeder and its ravages while not as insidious as the Maple Borer's are much more apparent.

Last summer this insect was exceedingly abundant in Quebec and Ontario, large areas of maples were completely defoliated by it and some of the groves appeared as if fire had passed over them. Many inquiries were received at Ottawa and there was considerable apprehension among the farmers as to the effect the injury would be likely to have on their sugar output. From Kingston a report showed that 130 acres of maples had been defoliated by the Leaf Cutter. At Perth Road, a point on the C.N.R. about 80 miles west of Ottawa, which I visited, a wood lot of 300 acres was stripped bare, and all the maples from Perth Road as far east as Chaffey's Locks, a distance of 10 miles, were in like condition. It was in the Eastern Townships however, that the damage was most severe. At Belle Vallée in the Township of St. Johns, very close to the centre of the Gipsy Moth infestation, there was a particularly heavy outbreak. About two-thirds of the foliage was off the trees and the remainder was riddled and skeletonized so badly that not a vestige of green remained. The ground, stones, and different objects around were thickly covered with the small circular cases. All

the beech trees in the wood were badly attacked, and the elms also showed signs of slight infestation. At Frelighburg an entire hillside instead of being green was changed to a dull reddish brown and attracted attention even from a long distance. Observations were made at a number of towns and villages in the counties of Missisquoi, Huntingdon and Brome and there was scarcely a place the insect was not to be found in large numbers.

Former Records

The first Canadian record of the Maple Leaf Cutter was made in 1872 by Mr. E. Baynes Reed who reported it about London, Ont., as being "unusual'y noticeable." Dr. Fyles observed an outbreak in Missisquoi County, Que., near Sweetsburg in 1881. Dr. Fletcher, in 1885, recorded it as being severe in Ottawa and instanced four acres of maples near Government House Grounds which were completely defoliated by this pest. In 1887, Dr. Fletcher again referred to it as "continuing to increase to an alarming extent." The only other reference I could find was one by Dr. Hewitt, in his 3rd Annual Report on page 182, where he speaks of *P. acerifoliella* as being very prevalent during the summer of 1911.

Adult

The adult is a microlepidopteron of a third of an inch spread, the forewings being bright steel blue and the unders smoky brown. A tuft of yellow hairs on the head gives the moth quite a characteristic and distinctive marking.

Larva

The larva when full grown is a quarter of an inch long, flat, cylindric in outline, and dull white in colour. For the first ten days of its existence it works as a miner in the leaf tissues. It then cuts out an oval case from the mine, top and bottom, making the lower half a little larger than the upper. This done it comes to the exterior, turns the case upside down, anchors it with silken threads to the leaf surface and continues to feed from within the protecting covers. When the second covering is to be cut out, the larva projects its head for a short distance beyond the case and makes a narrow slit right around its circular house. The new circle which now supports the old case is prevented from dropping to the ground by the silk threads, and when these are severed the circle is dragged away out of the hole in the leaf, inverted, and secured to the old case to form a new roof. This is done again for the third time, after which the cases fall to the ground where the larvæ transform to yellow-brown pupæ. From these the moths emerge in swarms during the later part of May to lay their eggs on the underside of the leaves.

Control

A lead arsenate spray of the usual strength of 1½ lbs. of powder to 40 gallons of water will hold the larvæ in check, and should be applied in early summer for the best results.

Raking the leaves and rubbish into piles away from the trees and burning same, where this can be feasibly done, will act as a good control. Some farmers object to this method on the ground that their trees are often injured by the fire. However, if carefully carried out, burning should not damage the trees and it certainly will kill off enormous numbers of the pupæ. This work can be done best late in the fall, or sometime in spring during the last of April or very early in May. Two factors enter into leaf-burning operations, viz., humidity and wind. If the weather is damp it is a waste of time to attempt burning; on the other hand if too dry burning becomes dangerous. Morning hours are not good for starting a fire because the wind is apt to rise after the sun gets well up, whereas in the afternoon the maximum temperature of the day has been reached by 2 p. m. and the tendency then will be for the wind to fall again, making it easier to extinguish fires at night fall. The question of burning for the control of the Maple Leaf Cutter is to be taken up more thoroughly this coming summer; the results of which will be published in due course of time.

PHYSIOLOGICAL SPECIALIZATION OF COLLETOTRICHUM LINDEMUTHIANUM IN EASTERN CANADA.

By K. A. Harrison, B.S.A., M. Sc.

Introduction.

A general study was made during the past winter in the laboratory and greenhouses of the Dept. of Botany at Macdonald College of the organism causing a very common disease of beans, and the following article reports on the most interesting phase of the work. While beans cannot be classed as a major crop in Canada still they are important enough to be considered as a staple one and of greater proportional importance to Quebec than the rest of Canada. The acreage and yield of field beans, the only ones of which it has been possible to secure statistics, has been decreasing since the war. The following table illustrates certain of these facts clearly and was compiled from the Monthly Bulletin of Agricultural Statistics (4).

The Yields in Bushels and Value of the Bean Crop.

—	1918 bu.	1922 bu.	Average from 1917–21	Average price 1917–21.
Canada	3,563,380	1,303,300	1,716,236	$ 8,613,200
Quebec	1,867,000	505,500	944,480	5,056,180
New-Brunswick	85,580	64,000	59,106	329,360
Nova Scotia	143,000	59,000	78,290	502,460
P. E. I.	No statistics avail	able.		

The disease under discussion, commonly called Anthracnose or Pod Spot of Beans, is the most serious disease that attacks them. It has been reported from as far north as Alaska, as far south as Australia, and has also been reported as occurring in the tropics, though it cannot be so serious there economically because of the fact that the disease thrives best in a temperature of 22.5 C. or 72.5 F. In the temperate zone, with a moderate climate and plenty of rainfall, the disease becomes the most frequent limiting factor that the farmer has to consider when planning his crop for the year. It attacks the bean plant in all stages of growth; it kills the seedlings after they start to develop; causes the leaves to drop by necrosis of the petioles on the more mature plants; spots the pods of both field and snap varieties; and disfigures the beans with brownish lesions and discolorations on the seedcoat. The disease is carried over winter in the beans themselves and it is spread in the field when moisture frees the spores so that they can be carried by some agency such as man, or splashed by falling rain drops.

Anthracnose of beans is caused by *Colletotrichum lindemuthianum* (Sacc. et Magn.) Bri. et. Cav. of the order Melanconiales of the Fungi Imperfecti. A perfect stage has been reported by Shear and Wood (8) as a Glomerella but it has not been generally accepted. The disease is of great interest to plant pathologists, not only because of its economic importance, but also because there are certain physiological species or forms within this species that have no morphological characters by which they may be distinguished but which have very different powers of infecting bean varieties.

The history of physiological specialization in *Colletotrichum lindemuthianum* dates back to 1911 when Barrus (1) made the announcement that he had discovered two strains of this pathogen by means of their ability to infect different varieties of beans. Since then several investigators have used this organism for a study of the number of physiological species present and their bearing in the breeding problem.

Barrus (2) continued his investigations and classified all the cultures that he had isolated. He found that they could be divided easily into two clear cut groups based on the infection results on the bean varieties used and designates them by the Greek letters *alpha* and *beta*. He also divided beans into

groups on their reactions to these strains; in the resistant group, he only found two varieties, Well's Red Kidney and White Imperial; a second group was resistant to *alpha* but not to *beta*; a third was resistant to *beta* but not to *alpha*; and the fourth was susceptible to both strains.

Edgerton and Moreland (5) in 1916 reported on the results of inoculations made with eight cultures and three reisolations from them, and considered from the infection results on the varieties used, that they had three strains of the pathogen One group was infectious on all but one variety used, viz: Large White Kidney, a second that infected Boston Pea heavily and Red Kidney lightly, and a third that infected Red Kidney severely but the Boston Pea lightly.

Burkholder (3) working in New York State reported on an isolation made from beans of the White Imperial variety that Barrus considered resistant; and found that he had a strain that was infectious on the White Imperial and which completely killed Well's Red Kidney, considered as the most resistant variety, in the seedling stage. He found, however, that the Michigan Robust which was resistant to the *beta* strain was also resistant to the new one. This strain was denoted by the Greek letter *gamma*. Burkholder considered that this new strain arose as a mutation from the *beta*.

The latest work was done by Leach (6) at Minnesota, who, as a result of inoculations made with fifteen cultures on sixteen varieties decides that he can distinguish eight physiological species and he set up a dichotomous key for tracing these species by a series of inoculations on seven varieties of beans. He attempted to find some other method of identifying these species but decided that the differences noted did not remain constant enough to use with certainty.

Experimental Work.

The present work has been largely along the lines of a study of the physiological specialization in *Colletotrichum lindemuthianum* in Eastern Canada, both as to the number of species present and the frequency of occurrence of any such species. Attempts were made to secure the perfect stage but they were unsuccessful.

The cultures used were largely collected from the Macdonald College farm from as wide a range of bean varieties as possible. Letters were also sent out to various places in Ontario, New Brunswick and Nova Scotia and samples of diseased pods and beans received. It was found impossible to isolate Colletotrichum from over one-half of these, due to the samples being heavily contaminated with secondary organisms before being received. A number of lesions not unlike anthracnose were noticed on Soy beans growing in the same patch with garden beans, but all attempts to isolate *C. lindemuthianum* failed. It is of interest to note that a bean pod from Nova Scotia, apparently infected with anthracnose of a very severe type only gave rise on culturing to *Phyllosticta phaseolina* Sacc. It was similar macroscopically in culture, and on the seedlings

the infection was so nearly identical that the first stages of Phyllosticta and *C. lindemuthianum* could not be told apart.

In addition to the cultures isolated here, Dr. B. T. Dickson supplied Barrus' *alpha* and *beta* strains and an isolation made from Quebec material. These were not in a sporulating condition and as it was found impossible to rejuvenate them, they were not used in any of the infection experiments.

Dr. J. G. Leach kindly supplied six of his cultures, one of which did not sporulate consistently and was not used for that reason in the infection experiments. The following in a list, with all the available information, of the cultures and their sources.

Cultures and their Sources.

Culture.

Alpha: Obtained from Dr. Dickson, who had received it from Dr. M. F. Barrus of Cornell University. It had been in culture for some time.

Beta: Obtained from Dr. Dickson, who had received it from Dr. M. F. Barrus of Cornell University. It has been in culture for some time.

Quebec Strain: Obtained from Dr. Dickson, who had isolated it from Quebec material. It had been in culture for some time.

Leach's Forms I, II, III, IV, and VIII were all supplied by him from cultures used in his work (6).

1. Isolated by H. R. Angell, Oct. 1st. from a bean from a private garden in Ste. Anne de Bellevue.
2. Isolated from a black kidney bean from the Horticultural Department's plots.
4. Isolated from a wax podded bean that was not seriously infected, Horticultural Department.
5. Isolated from a green podded type that was not seriously infected, Horticultural Department.
6. Isolated from a yellow wax-podded bean, Horticultural Department.
16. Isolated from a pod of Perry's Special, School plots on the College farm.
23. Isolated from bean seeds that Dr. Dickson had secured from the Horticultural Department. (Very heavily infected.)
25. Isolated from a wax podded bean showing very large lesions, Horticultural Department.
26. Isolated from a bean pod sent in from Maugerville, N. B. Unknown variety.
29. Isolated from a bean pod sent by Dr. M. F. Barrus, Cornell University. An unknown variety and very seriously infected.
30. Isolated from a bean pod sent by Dr. R. E. Stone, Guelph, Ont. Bean No. 7251.
31. Isolated from a bean sent by Dr. R. E. Stone, Guelph, Ont. Bean .5022.

32. Isolated from a bean pod sent by Dr. R. E. Stone, Guelph, Ont. Bean No. 7521. Early brown.
33. Isolated from a bean pod sent in by Dr. R. E. Stone, Guelph, Ont. Bean No. 7621. Brown.
35. Isolated from a wax podded black kidney type secured from Maugerville, N. B.
36. Isolated from a green podded type purchased by Dr. B. T. Dickson in the Ste. Anne de Bellevue market in April, 1925.

All the cultures not specifically mentioned were isolated in October and early November of 1924.

The beans for the inoculation experiments were secured from several places. Dr. J. G. Leach was kind enough to send the varieties that he names in his bulletin for his key.

The cereal Division of the Central Experimental Farm, Ottawa, supplied seven varieties grown there.

The largest number were secured by the kindness of H. M. Racicot, who supplied the varieties being tested at Ste. Anne de la Pocatière Experimental Station. The following is a list of all the varieties received.

List of Varieties of Beans and Sources.
From J. G. Leach, Minnesota.

Brown Swedish, Minn. 132.
Navy, Minn. 69.
Red Kidney, Minn. 156.
Red Indian, Minn. 1101.
Navy, Minn. 1083.
Ruby Horticultural Bush, Minn. 98.
Improved Yellow Eye, Minn. 1096.

From Central Experimental Farm, Ottawa.

Golden Wax Selected.
Yellow Eye.
Robust Navy.
Navy, O.711
Robust.
Large White, O.713.
Well's Red Kidney.

From Ste Anne de la Pocatiere.

No.		Reaction to culture 1.
1.	Wardwell's Kidney Wax.	S
2.	Davis' Kidney Wax.	CS.
3.	Well's Kidney Wax	R
4.	Black Seed Wax Prolific.	S
5.	Prolific Black Wax.	CS.
6..	Black Seeded Wax	CS.
7.	Early Black or Butter Wax.	S
8.	Improved Golden Wax.	CS.

No.		Reaction to culture 1
9.	Golden Podded Wax.	CS.
10.	Michigan White Wax.	CS.
11.	Davis' White Wax.	VR.
12.	Round Pod Wax.	CS.
13.	Detroit Wax (D. M. Ferry)	CS.
14.	Hudson Wax.	CS.
15.	Wax Chief.	S
16.	Stringless Refugee Wax.	CS.
17.	Valentine Wax.	CS.
18.	Yosemite Wax.	CS.
19.	Giant Stringless Green Pod.	SS.
20.	Ely Stringless Green Pod.	CS.
21.	Stringless Green Pod.	CS.
22.	New White Selected Green Pod.	VR.
23.	Bountiful Green Pod.	S.
24.	Davis' Green Pod.	R.
25.	Green Pod Refugee.	S.
26.	Yellow Eye.	CS.
27.	Improved Yellow Eye.	SR.
28.	Yellow Eye, Mammoth Me. 1317.	S
29.	Yellow Eye, Mammoth Me. 1377.	S
30.	Yellow Six Weeks (short strain)	S
31.	Yellow Six Weeks'	VR.
32.	Early Yellow Kidney Six Weeks.	CS.
33.	Early Yellow or Six Weeks.	CS.
34.	Chinese Bush.	CS.
35.	White Bush Bean (vary)	
36.	Early Valentine or Podded.	CS.
37.	Early Red Valentine.	CS.
38.	Extra Early Red Valentine.	CS.
39.	Mohawk.	CS.
40.	Early Mohawk.	CS.
41.	Horticultural Dwarf.	CS.
42.	Dewarf French Excelsior.	S.
43.	Refugee or 1000 to 1.	CS.
44.	Extra Early Refugee.	CS.
45.	White Pea Bean.	VR.
46.	Marrowfoot (George Saunders)	CS.
47.	White Navy.	VR.
48.	Soldier Bean.	S.
49.	Fordhook Favorite.	VR.
50.	California Wonder	VR.
51.	French Lima.	CS.
52.	May Queen	S.
53.	Honey Pod.	CS.
54.	Cornell Rustless.	S.
55.	Veitch Hybrid.	
56.	William, Earliest of All.	CS.
57.	Long Pod Forcer.	C.S
58.	Selected Canadian Wonder	VR.
59.	Early China	S
60.	Sure Crop Stringless.	CS.

No.		Reaction to culture 1.
61.	Full Measure Bushel.	CS.
62.	Mighty Nice.	CS.
63.	Plentiful French.	CS.
64.	Non Pareil.	S.
65.	Ne Plus Ultra.	CS.

Inoculation Experiments.

After a few preliminary lots of beans had been inoculated to study the conditions necessary for infection, culture No. 1 was used to inoculate the varieties of beans received from Ste. Anne de la Pocatière and from these results, which are given with the list of vaieties, sixteen were selected largely on account of their showing resistance or types of resistance. One completely susceptible and three susceptible were included, the aim being to get a variety of reactions to the various cultures and at the same time test out those resistant as far as the time available allowed. All the cultures sporulating at the time of making the inoculations were used on the sixteen varieties.

The beans were grown in pots in the greenhouse on benches and were inoculated as soon as the first pair of true leaves had spread out. Such early inoculation was to eliminate any danger of differences of resistance from the ageing of the tissues. This plan made it necessary to inoculate on different days; 48 hours being the longest apart of the inoculations on any one variety.

In addition to the age of the tissue as a factor in resistance it was later found that ordinary fluctuations in weather conditions produced an error just as great, though more easily determined.

Inoculations were made by carefully spraying all parts of the seedlings with a turbid suspension of spores with an atomizer. All spore suspensions were made equally turbid and the atomizers were sterlized, after each culture used, in 60 per cent alcohol for at least five minutes.

The plants were placed in a moist chamber after inoculating and kept in a greenhouse normally run at 70 F. At the end of 48 hours they were removed and placed on benches and observations made each day, until the tenth after inoculation when the final records on the degree of infection were taken.

Signs of infection were usually easily seen on the sixth day though it ranged from early on the fifth to the seventh. In some cases of extreme susceptibility, the plants had completely wilted and fallen over on the sixth day. This condition was peculiar as there were no signs of the typical brown lesions; just water soaked areas being present on the stem on which, in a day or two, acervuli, producing-spores, showed as brown flecks. This early wilting and dying must not be confused with the wilting that was so often evident when the plants were first taken from the humid atmosphere of the moist chamber. This latter condition was never present after the first 24 hours and the plants appeared perfectly healthy until the sixth or seventh day when they again wilted and died completely if they were a susceptible variety.

For convenience in taking records letters were used indicating the degree

of infection evident upon the seedling. Five classes were made taking in as far as possible an equal range of infection. Fig. 1 illustrates this.

VR stands for "very resistant" and the plants only show a reddish flecking.

R stands for "resistant" and the plants show small lesions that do not develop into typical anthracnose spots.

SR stands for "slightly resistant". The plants show many small lesions that do not develop but with them are lesions that interfere to a slight degree with the growth of the plant. This division includes the doubtful cases of resistance and susceptibility and according to observations a difference in environmental factors might easily place these into either the resistant or susceptible groups.

S stands for "susceptible". The plants produce typical lesions that develop acervuli and spores by the time the records are taken.

CS stands for "completely susceptible". The plant is dead or so nearly so that it will not recover.

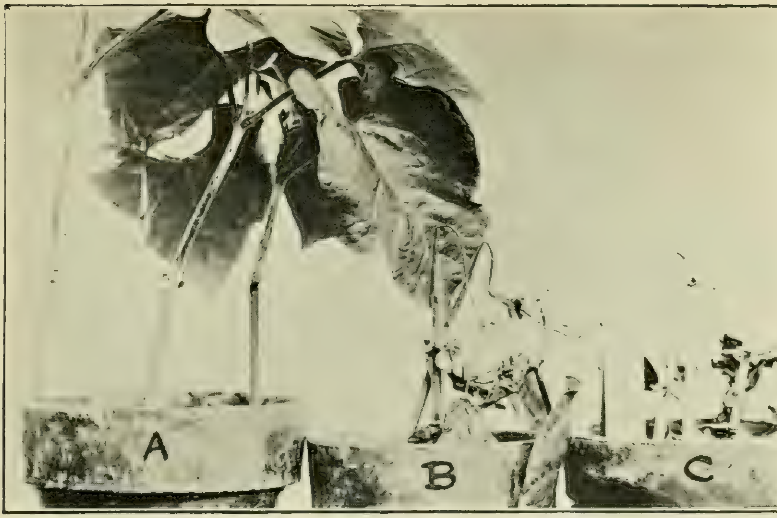
The taking of records was often rendered difficult by reason of the different effects on bean varieties as for example on pea and wax beans.

Discussion of Tables.

The following table shows the reactions of all the cultures isolated during the work on thirteen varieties of beans. Three other varieties, Well's Kidney Wax, Selected Canadian Wonder, and Dwarf French Excelsior, were also used in this experiment, but a few beans were found in each that gave such a different type of infection that they were left out. These varieties were therefore not considered as being pure line strains and possibly they did not constitute a pure variety.

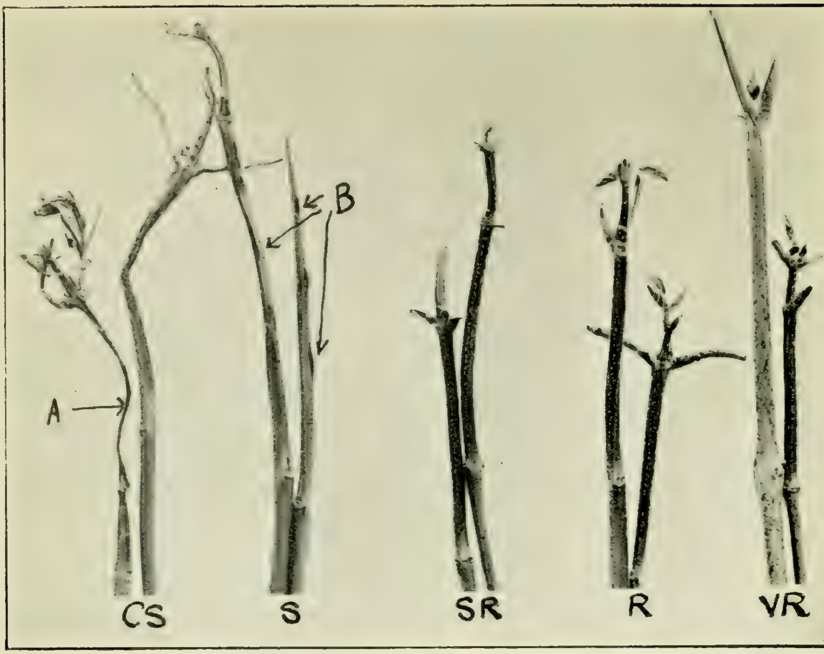
A study of Table II shows five varieties that gave a uniform reaction to all the cultures; Well's Red Kidney is one of these; the difference noted being attributed to a change in weather conditions as one part was inoculated on a fine day and the rest on a rainy. In considering the remaining eight varieties, it is noticed that the majority of the cultures give nearly identical results on the bean varieties. Cultures, 2, 4, 5, 26 and 31 are identical in their infection capacities, 6, 25 and 29 vary but little from them, and 1, 30 and 32 vary a little more widely but only on the White Pea Bean which was the first to be inoculated. It is quite possible that errors might have crept in that would explain any such minor differences, especially so in this case for it has already been pointed out that with pea beans it is often difficult to be certain of the degree of infection. Culture 33 varies more widely still and is resisted by a variety that was completely susceptible to all the other cultures and is infectious on a variety that constantly shows varying degrees of resistance to other strains.

The remaining four cultures vary quite markedly. Yellow Six Weeks is completely susceptible to culture 36 and this is a variety that is very resistant to all of the other cultures. Culture 36 also shows a slight difference on large White, 0-713 and on this variety gives a similar reaction to 16 and 35. Cul-



Nonpareil inoculated with
A—Culture 23
B— " 2
C— " 5

Improved Yellow Eye
A—Culture 31
B— " 29
C— " 23
D— " IV



Bean stems from plants showing gradation from complete susceptibility to complete resistance.

Bean leaflets showing typical lesions at A.

TABLE II

Infection obatined with sixteen cultures on thirteen varieties of beans.

VARIETY INOCULATED	CULTURE NUMBERS														
	1	2	4	5	6	16	23	25	26	29	30	31	32	33	35 36
Wardwell's Kidney Wax	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS
Davis' White Wax	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR
New White Selected Green Pod	VR	VR	VR	R	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	CS
Davis' Green Pod	SR	SR	SR	SR		VR	VR		SR	SR	SR	SR	SR	S	SR
Improved Yellow Eye	CS	CS	CS	CS	CS	CS	SR	S	CS	S	CS	CS	CS	CS	CS
Yellow Six Weeks	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	CS
White Pea Bean	S	SR	SR	SR	R		SR	SR	SR	R	S	SR	S	SR	
Marrowfat	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	R	CS
Fordhook Favorite	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	
Non Pareil	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS
Large White, 0.713	CS	CS	CS	CS	CS	S	CS	CS	CS	CS	CS	CS	S	S	S
Robust	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR
Well's Red Kidney	R	VR	VR	VR	VR	VR	VR	VR	VR	VR	R	R	R	R	R

tures 16 and 35 differ on two varieties and 23 on three. It might be a matter of doubt in the case of a very resistant variety if error had not crept in and interfered with infection. This, however, did not seem possible for in some cases more than one variety was inoculated and one would show typical lesions and the other would have to be classed as very resistant.

Table III shows five of Leach's Forms and their infection capacities on the same thirteen varieties used in Table II.

TABLE III

Infection obtained with five of Leach's cultures on thirteen varieties of beans.

VARIETIES INOCULATED	LEACH'S FORM				
	I	II	III	IV	VIII
Wardwell's Kidney Wax	CS	CS	CS	S	S
Davis' White Wax	VR	VR	VR	CS	
New White Selected Green Pod	VR	VR	VR	CS	VR
Davis' Green Pod	SR	SR	S	CS	VR
Improved Yellow Eye	CS	CS	S	VR	
Yellow Six Weeks	VR	VR	VR	CS	VR
White Pea Bean	S	S	S	CS	S
Marrow Fat	CS	CS	CS	CS	R
Fordhook Favorite	VR	VR	VR	CS	
Non Pareil	CS	CS	CS	CS	CS
Large White 0.713	CS	CS	CS	S	S
Robust	VR	VR	VR	CS	VR
Well's Red Kidney	R	R	R	VR	R

Forms I and II are identical in their infection capacities on the variesties in Table III, and Form III differs slightly on two varieties only, with VIII differing on three. Form IV is strikingly different indeed, as practically every variety is susceptible to it. The only two varieties resistant to this culture are Well's Red Kidney and Improved Yellow Eye.

Table IV shows the degree of infection obtained on Leach's differential hosts. The beans were all planted the same afternoon and the seedlings were were inoculated at the same time under uniform conditions.

TABLE IV

Infection obtained on Leachs' differential hosts with fifteen culture.

VARIETY INOCULATED	Form.	I					II					VIII				
	Culture No.	4	6	31	32	33	2	5	25	26	35	1	16	29	30	23
Brown Swedish......	Minn. 132...	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS
Navy..............	Minn 69....	SR	SR	CS	SR	CS	SR	S	CS	CS	SR	R	R	VR	VR	R
Red Kidney........	Minn. 156...	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS
Red Indian.........	Minn. 1101..	CS	S	CS	CS	CS	R	R	R	R	R	R	R	R	S	R
Navy..............	Minn. 1083..	VR	R	VR	VR	VR	VR	R	VR	VR	VR	CS	CS	CS	CS	CS
Ruby Hort. Bush....	Minn. 98....	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS
Improved Yellow Eye	Minn. 1096..	CS	S	CS	CS	CS	CS	CS	CS	CS	CS	S	CS	SR	CS	VR

Of the seven varieties inoculated, three showed extreme susceptibility to all of the cultures used, and one was uniformly resistant. Red Indian, Minn. 1101 which is used to separate Form I gave a very peculiar reaction to the various cultures. Those marked CS were very badly infected and died, but the lesions were not typical of the usual CS type of infection. They were superficial in appearance and did not kill so quickly.

Leach's dichotomous key (6) was used to separate the various cultures into the following groups: Form I:—4, 6, 31, 32, and 33. Form II:—2, 5, 25, 26, and 35. Form VIII: –1, 16, 29, and 30. Culture 23 also comes in Form VIII but Improved Yellow Eye, Minn. 1096 is very resistant to it. Apparantly it does not fit in with Form VII for Ruby Horticultural Bush, Minn. 98 is completely susceptible.

A close inspection of these three groups, made by using the key, shows that they can still be split into other groups. Thus under Form I we have 31 and 33 similar, and 4, 6, and 32 forming another set. Under Form II, 2 and 35 go together, while 5, 25, 26 constitute a group with similar reactions. Form VIII is not so clear but 16 and 30 are closely similar while 1 and 29 are individuals.

A comparison of all three infection tables would seem to show the following facts:—It is impossible to distinguish I and II from the majority of the cultures isolated here during the course of the work, on the Quebec varieties of beans

used. Form III differs so little that it is a matter of doubt if it could be positively determined, but VIII gave differences that showed in the tables. The differences observed with Leach's Form VIII are not shown, however, by the group that comes under it when using his differential hosts. The recently isolated culture 36 caused infection similar to that obtained with IV. This was also observed on Well's Kidney Wax, which was not included because of four plants that were susceptible when all the rest were resistant, excepting in the case of Form IV, and culture 36, where all the plants were susceptible.

A Group Separated by Cultural Characteristicts.

Constant watch was kept from the first for any differences in the cultures on the various media used to see if it were possible to identify the various cultures or forms from one another and if any such differences did appear to see if they confirmed the differences in infection results. Leach's Forms when first transferred to potato dextrose agar gave quite noticeable variations but these gradually disappeared in all cases but IV, and V, V being easily identified by a whitish colony and very poor sporulation. There appears to be a constant relationship between a whitish colony and poor sporulation. The distingishing characters of IV remained constant on potato agar and were identical with cultures 16 and 35. These cultures on slants of potato dextrose agar were slower growing; had a tendency to lobing at the edge and formed a thick stroma-like mat of mycelum that developed very few spores and which as the colony aged took on a very characteristic wrinkled appearance. The slow growth and lobing of the margin was very evident in plate cultures but the stoma-like mat of mycelium and wrinkled surface seldom showed. It is interesting to note that the recently isolated culture 36 is showing a tendency to lobing at the margin of the colony and is a very slow grower. No differences in spore sizes were found.

A comparison of Cultures on Different Sources of Carbon.

The only work done on this that has been noted was by Leach (6). He obtained such marked differences with mannitol that all cultures on hand at the time were grown on a modified Czapeck's solution with it as the carbon source.

The solution used is as follows:—0.5 gm. magnesium sulphate, 1.0 gm. monobasic potassium phosphate, 0.5 gm. potassium chloride, 0.01 gm. ferrous sulphate, 2.0 gm. sodium nitrate and 30.0 gm. of cane sugar in one litre of distilled water. This solution was made up without the sugar, and the salts for 1000 cc. were mixed with 900 cc. of water. 45 cc. of this solution was placed in each flask which were two sizes, one holding 200 cc. and a check that held 150 cc. These were plugged and autoclaved at 17 lbs. pressure for twenty minutes. After they had cooled, 5 cc. of an 8 per cent solution of the carbon source was added, which made the concentration of the sugar in the culture 0.8 per cent. The carbon source was first sterilized by using a Chamberland filter. The flasks were inoculated by washing off all the spores that could be picked up in a

sterile loop. In cases where spores were not being produced in the four cultures that would not sporulate, a small portion of mycelium was transferred. The cultures were allowed to grow for forty days in a temperature held between 22° and 24° C. The weights of dried mycelium are given in Table V.

When the cultures were split up according to Leach's differential hosts, it was seen that the cultures that came under:—

Form I gave an average weight of .0157 gm.
Form II " " " " " .0088 '
Form VIII " " " " " .0096 "
While Leach's Form I gave an average for two flasks of .0625
" Form II " " " " " " .112
" Form VIII " ' " " " " .0125

There does not seem to be any possible correlation between them, but when the weights are taken of the groupings that apeared as a result of the infections that are shown in Table II, it is possible to see a certain amount of uniformity. Cultures 2, 4, 5, 26 and 31 that are identical in Table II give an average weight

TABLE V

Growth weights on modified Czapeck's Solution with Mannitol as the Carbon Source.

CULTURE	DRY WEIGHT OF MYCELIUM IN GRAMS			
	Flask 1.	Flask 2.	Total	Average
Alpha	....	.046	.046	.046
Beta	.084	.100	.184	.092
Quebec Straim	.C65	.046	.111	.C555
I	.095	0.30	.125	.0625
II	....	.112	.112	.112
III	.012	.C07	.019	.C095
IV	.003	.00C	.003	.0015
V	.018	.014	.032	.016
VIII	.012	.013	.025	.0125
1	.008	.C05	.C13	.0065
2	.007	.C05	.012	.006
4	0.07	.013	.(20	.010
5	.C11	.005	.016	.008
6	.035	.008	.043	.0215
16	Very slight gr	owth.		
23	.007	.013	.020	.010
25	.025	.017	.042	.C21
26	.010	.007	.C17	.0085
29	.030	.011	.041	.0205
30	.C12	.010	.022	.011
31	.009	....	.0C9	.C09
32	.011	.014	.025	.0125
33	.042	.009	.051	.0255
35	.C01	....	.001	.0005

of .0083 of a gram, F .0023, cultures 1, 30, and 32 have an average weight of .01, F .0035, and cultures 6,25, and 29 are .021, F .0005 in average weight. Culture 33 which is .0255 is similar in weight to these 'ast but differs somewhat in

nfection. Culture 23 which has an average weight of .01 agrees with the second group but has different infection capacities as shown by Tables II and IV. Culture 16 and 25 are outstanding in the very small amount of growth and agree with IV on this media as they did on potato dextrose agar.

Taking these results it is possible to divide the cultures into the following three groups:—

I. 2, 4, 5, 26, 31; 1, 30, 32 and possibly 23.
II. 6, 25, 29 and 33.
III. 16 and 35.

Table IV shows the weights obtained in a test with four cultures on four carbon sources. A fifth source of carbon was used but only gave a trace of growth. Four of the most interesting of the cultures were selected for this test which, however, was only allowed to run four weeks on account of the time available.

TABLE VI

Selected cultures growth on Czapeck's solution modified in carbon source.

CULTURE	Dry Weight of Mycelium in Grams				Carbon source.
	Flask 1.	Flask 2.	Total	Average	
16*	.005	....	.005	.0025	Maltose.
2	.113	....	.113	..13	"
23	.142	.152	.294	.147	"
35*	No weight	evident.	Slight growth		"
16*	.006	....	.006	.003	Aspagarin.
2	.040	.024	.064	.032	"
23	.023	.023	.046	.023	"
35*	.006	....	.006	.003	"
16*	.015	....	.015	.0075	Dextrin.
2	.058	.060	.118	.059	"
23	....	.065	.065	.065	"
35*	.020	....	.020	.010	"
16*	.007	....	.007	.0045	Dextrose.
2	.107	.115	.222	.111	"
23	.090	.117	.207	.1035	"
35*	No weight	evident.	Slight growth		

* Growth so slight that both were put together to get the weight.

Cellulose acetate was also tested but the growth was so slight that it could not be weighed.

Again the most striking fact is the very low weights of mycelium obtained from cultures 16 and 35, on all the carbon sources. Cultures 2 and 23 give appreciable differences in average weight on maltose and asparagin.

Testing the Nutrient Requirements by Triangulation.

It was hoped that interesting variations might appear if the nutrient requirements were worked out after the method of Young and Bennet (9) and used in 1923 by Scott (8) in working out the relationships of a group of cultures to prove that they were all one Collectotrichum. A series of twenty-one cultures, using potassium acid phosphate (monobasic), calcium nitrate and magnesium sulphate were set up. The salts varied in the different solutions by increments of one-eighth and had an osmotic concentration of three and one-half atmospheres. Sucrose was added in equal amounts 3.42 grams per 100 c.c. of the culture, thereby giving the culture solution a total osmotic pressure of four ad one-half atmospheres.

In these triangles the individual cultures are numbered according to the row in which they occur and according to their position in the row. The rows are numbered from the base to the apex of the triangle. The position in the row is from left to right. Thus the culture on the extreme left of the first row is numbered 11, the second from the left in the third is 32, and in this way every culture received a number.

The method of arranging the concentrations is given in the following table.

TABLE VII

Showing the amounts to use in making up the flasks for the triangulation experiment.

Flask No.	cc. of M*l*14 KH2 PO4	cc. of M*l*14 Ca (No3) 2	cc. of M*l*14 MgSO4	cc. of sugar sol. 3.42 gm in 10 cc.	Water to make sol. to 50 cc.
11	4.0	4.0	22.4	5	14.6
22	3.5	6.8	17.2	5	17.5
13	34.	10.0	13.2	5	18.4
14	3.1	12.4	9.4	5	20.1
15	3.1	15.0	6.0	5	20.9
16	3.0	17.0	2.8	5	22.2
21	7.4	4.0	17.2	5	16.4
22	7.0	6.8	13.2	5	18.0
23	6.5	10.0	9.4	5	19.6
24	6.2	12.4	6.0	5	20.4
25	6.0	15.0	2.8	5	21.2
31	10.6	4.0	13.2	5	17.2
32	10.0	6.8	9.4	5	18.8
33	9.5	10.0	6.0	5	19.5
34	9.0	12.4	2.8	5	20.8
41	13.8	4.0	9.4	5	17.8
42	13.2	6.8	6.0	5	19.0
43	12.6	10.0	2.8	5	19.6
51	17.2	4.0	6.0	5	17.8
52	16.4	6.8	2.8	5	19.0
61	20.3	4.0	2.8	5	17.9

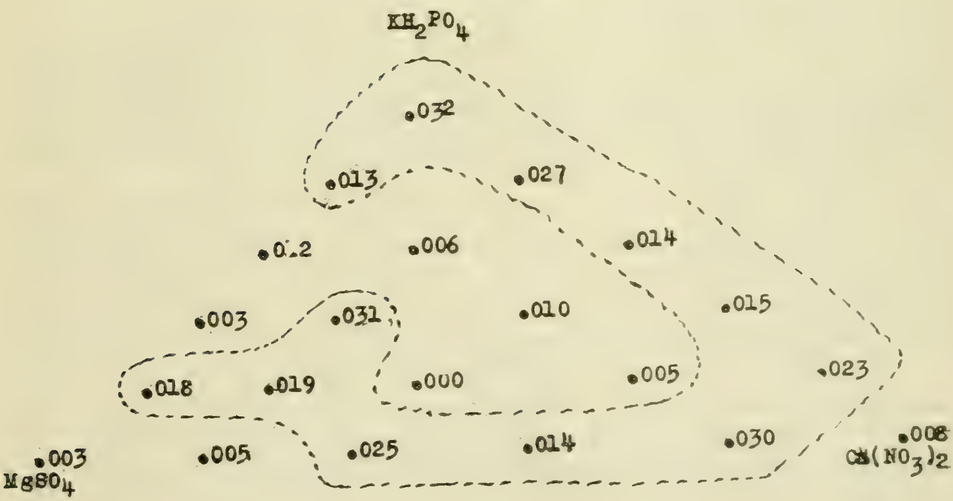
The flasks containing the media were autoclaved at seventeen pounds pressure for twenty minutes and after cooling were inocu ated ith 1cc. of a turbid spore suspension. The cultures were allowed to grow for four weeks under the same conditions as the other growth experiments, and the results are given in Table VIII.

TABLE VIII

Triangulation to determine the nutrient requirements.

Culture No.23 (weights in gms.)

Culture No. 16.



Again the most noticeable feature is the very slight growth made by 16. Culture 23 gave excellent growth and on many of the flasks a mycelial mat that produced spores was formed on the surface of the solution.

In making a contour that surrounds the cultures giving the largest amounts of mycelium in each triangle, it is noticed that one appears as though it could be fitted into the other almost like a key into a lock.

The identity of the cultures isolated.

These have already been compared with those from Leach's work. In comparing them with the results obtained by Barrus and Burkholder, it does not appear that Burkholder's *gamma* strain has been isolated so far as the present work goes. Barrus reports pea beans as resistant to the *beta* strain and Burkholder that the Robust variety is also. In the inoculation experiments White Pea Bean and Robust were resistant to the Canadian cultures used. It was noted that Barrus and Edgerton both reported the Davis, a wax podded bean as susceptible to all strains. Davis' White Wax here seems to be very resistant to all but IV. It cannot, however, be definitely stated that the two varieties are the same.

An attempt to secure the perfect stage.

This was a test to see if possibly there were plus and minus strains of the organism. All the cultures were used in this attempt so that the mycelium of every culture would mingle with mycelium from every other. A full test was made on potato dextrose agar and a few selected ones on cornmeal, oat decoction green bean and Czapeck's synthetic agars, but in all cases negative results were obtained.

Summary and conclusions.

1. A total of twenty-one cultures was used in a series of inoculation experiments on sixteen varieties of beans. results being given from thirteen as the other three were considered consisting of more than one pure line strain. These varieties were selected as a result of a preliminary test with sixty-five varieties inoculated with culture No. I.

2. Fifteen cultures isolated in the work were used to inoculate the seven varieties that Leach has used as differential hosts and using his dichotomous table they fall within Forms I, II, VIII. but considering the results as a whole these groupings are not uniform. The amount of seed for this experiment was limited and further work is almost certain to modify some of the discrepancies.

3. Culture 36 (probably from Florida) is considered as a separate strain and identical with IV and by comparing its reactions with those of Barrus' cultures it is considered as belonging to his *alpha* strain. All of the other cultures isolated during the course of the work are considered as coming under his *beta* strain. Some of the cultures show differences, but it is quite possible that

under slightly different conditions at the time of inoculation that these would come definitely under the *beta* strain.

4. A significant fact is that the *alpha* strain was not isolated out of fourteen cultures from Canadian material. It is known to be present, however, as varieties used here, known to be resistant to the *beta* and susceptible to the *alpha* have been reported as susceptible at the Experimental Stations where they have been tested.

5. Culture **23** gave the widest range of those worked with but not wide enough to take it out of the *beta* strain. It also differs widely from Form VIII when using Leach's key. In testing 23 on carbon sources it is found to differ from 2, a typical culture of the class to which the Canadian isolations are considered to belong, on maltose and asparagin.

6. The only variety found resistant to all the cultures used was Well's Red Kidney. The varieties that proved resistant to the cultures from Canadian sources were Navy, Minn. 73, Davis' White Wax, Yellow Six Weeks, Robust and Fordkook Favorite (the latter not tested with culture 35). The last four varieties are from Quebec and were susceptible to Leach's Form IV.

7. Differences were noted on potato dextrose agar that remained constant and made it possible to identify cultures 16, 35 and IV whenever grown on that substratum. A study of these cultures in all the physiological experiments show that they are constantly associated wherever tested. Cultures 16, 35 and IV were not similar, however, in infection capacities on the varieties of beans inoculated.

8. A comparison of the infection results of the cultures isolated during the course of the work with their growth weights on mannitol shows that cultures grouped from slight differences in infection also gave different average weights.

9. The triangulation experiment brings out the differences between cultures 16 and 23 very markedly as the growth contours will partially fit into each other like a lock and key.

10. An attempt was made to secure the perfect stage from any of the isolations by growing several cultures in one plate so that the colonies would run together. No sign of a perfect stage was evident.

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PRELIMINARY REPORT ON A DISEASE OF COMMON BEAN

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Introduction

During the fall of 1924 while engaged in isolating cultures for a study of the physiological specialization in *Colletotrichum lindemuthianum* an organism was secured from a bean pod which later was considered as being identical with or very closely approximating the organism that is described as *Phyllosticta phaseolina* Sacc.

A search of the available literature has not given a very full description of the organism and disease and but very little as to its range. Martin (1) reports it as occurring on *Phaseolus diversifolius* in 1886. Farlow (2) in 1888 in his host index records that it is on the same host and also on *Phaseolus vulgaris.* Kellerman collected it in Ohio in 1901 on *Stylosanthes biflora* (L.) B.P.S. Harter (3) in an article on pod blight of lima beans caused by *Phoma subcircianata* E. & E. states that the two diseases may be confused and states that the following reports have been made; New Hersey (Ellis), Canada (Dearness) on *Phaseolus perennis,* Missouri (Galloway) and on cowpea, Kansas (D.B. Swingle). Coons (4) in 1916 reported a leaf spot on *Phaseolus vulgaris* which caused some anxiety to the growers in Michigan and states that it was due to a cowpea disease caused by *Phyllosticta phaseoli.* Cook (5) in a circular on diseases of peas and beans makes no reference to this organism when discussing "Pod Blight and Leaf Spot of Lima Beans (*Diaporthe phaseolarum*)", but states that "The disease on the pods and on the leaves was originally supposed to be two distinct diseases".

Harter, however, in his article on *Diaporthe phaseolarum* states very definitely that there are two diseases, one a leaf spot and the other a pod blight.

Apparently the original and only work on the pathogenicity of this organism was done by C. O. Smith (6), who was certain that he had the Phyllos-

ticta reported by Saccardo and considered that he did not have *Phoma subcircinata* E. & E. reported in 1892 and worked on by Halstead, as he states that the descriptions do not fit. In his inoculation experiments he used and infected wax and kidney beans, lima beans and cowpeas, and states that infection is entirely confined to the leaves. Smith's article seems to be the only one that gives a description of the organism and is not as full as one might wish so a brief study of the organism isolated was made.

History of culture.

Last autumn requests were sent out for bean pods affected with anthracnose and amongst other samples, one was received from a friend in Central Clarence, Annapolis Country, N.S., who was not familiar with diseases of plants in general. The sample was accompanied by a statement to the effect that it had been difficult, to secure spotted pods as there was very little disease on any of the beans. On opening the sample a large number of pods were found with very tiny flecks, but amongst them was a pod that had very large lesions which appeared identical with those produced by *Colletotrichum lindemuthianum*, excepting in the matter of size. Pieces of this severely affected pod were planted in plates of potato dextrose agar but the only result was an organism that developed rapidly and had a whitish superficial type of growth. This was set on one side in the hopes that later it would be possible to identify it. Spores were not in evidence until after Christmas when what looked like pinkish rhizomorphs were noticed penetrating into the substratum from the lower surface on the mycelial mat. These on investigation proved to be masses of spores less than half the size of those of *C. lindemuthianum*. A spore suspension was made in sterile water and diluted until it was estimated that 2cc. would contain about 25 spores and this amount was poured on the surface of plates of potato dextrose agar. The resulting colonies were different from the original but all had the same appearance and macroscopically were of the general Colletotrichum type. Transfers were made to agar slants and the organism studied in pure culture, the cultures being carried under identical conditions with those of *C. lindemuthianum*.

The organism.

Upon examination the main characters of this organism were found to come fairly close to Saccardo's description of *Phyllosticta phaseolina* Sacc. which is as follows; "Maculis amplis, vagis arescendo ochraceis; peritheciis sparsis, lenticularibus, 70 u diam. pertusis; sporulis ovoideo-oblongis, 6 by 2.5, rectis, rarius inæquilateralibus, hyalinis". Smith gave the description of the organism that he works with as follows; "Spots irregularly scattered, subcircular, 2-10 mm. in diameter, deep rusty brown, becoming lighter in the centre, and margin darker. Perithecia scattered, lenticular, 70-90 microns in diameter, sporules ovoid oblong, mostly straight, 4-6 x 2-2.5 microns. On leaves of

various Phaseoli." He then goes on to state that while Halsted illustrates leaf spots from the organism that he worked with, at the same time as spots on the pods, he (Smith) had not been able to get infection on the pods with his own organism. In looking up Halsted's pictures of "Pod blight of lima beans", it was interesting to note that they do not differ very widely from the picture taken of the original material for the present cultures.

Harter in his comparison of the disease with that caused by *Phoma subcircinata* states that "The spots are smaller, more nearly round and the pycnidia are smaller and fewer in number.

The peculiarity of the organism studied here is that it was isolated from a pod that had large lesions but in the inoculation experiments it caused a leaf, stem and flower spot with only very slight spots on the pod.

The disease.

So far I am under the disadvantage of having only examined the disease critically on beans artificially inoculated under greenhouse conditions, and on leaves it is rather like the description given by Smith but it was not found that the lesions are confined to the leaves. Lesions were easily obtained on the flowers, flower-buds, stems, leaf petioles and pods. They are only slight on the pods, however, and frequently appeared only as fine flecks.

On the leaves.

Smith's description of a light centre and a darker margin will only apply to about one-half of the spots. Many of those observed having a distin tly dark centre and then a lighter ring w th a dark margin next the living tissue. The leaf spot is also marked with dark lines formed by the leaf veins being a darker brown than the other tissue.

On the flowers and flower buds.

The worst feature of this disease as observed in the greenhouse was the severity with which the developing flower buds were attacked. The lesions formed on the unfolding petals and sepals and when a flower bud was once attacked it ceased normal development, turned brown and dropped off within a few days. It was observed that the parts of the flower bud were the most readily attacked.

On the stems and petioles.

The lesions were a deep reddish brown and ranged in size from 1 to 20 mm. in length. Some were observed to be much longer but as they continue developing it was considered that they resulted from the coalescing of several. The lesions were generally narrow extending lengthwise of the stem but as the plant matured they widened and in some cases extended entirely around in the case

Bean pod infected with P. PHASEOLINA. Note lesions.

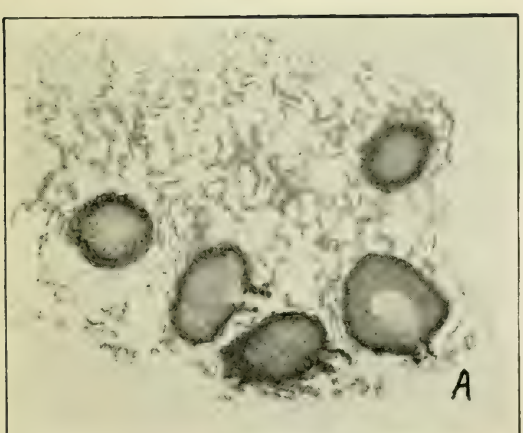
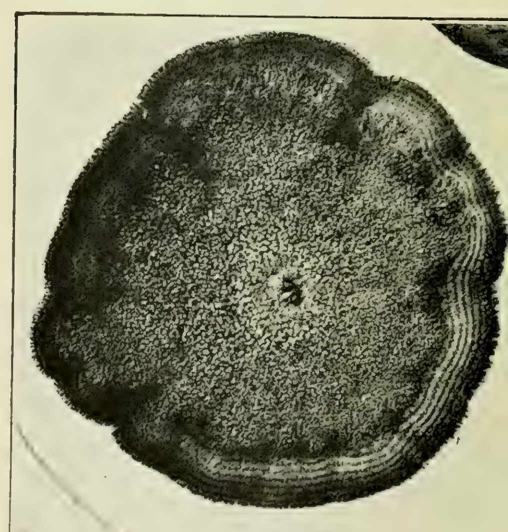


Photo micrograph of P. PHASEOLINA Spores oozing at A



Culture of PHYLLOSTICTA PHASEOLINA showing masses of spores on surface.

of a petiole attacked and half way in the case of a stem. It was noticed that the majority of the lesions were near the nodes or where the cotyledons had dropped off. The lesions elsewhere had a slightly different shape and were often quite sharply pointed at the upper and lower extremities.

On the pods.

Here as it has already been mentioned the lesions are very small and seldom developed over 1 mm. in diameter. These lesions were very dark in color. The centre was nearly black with a reddish margin. The developing bean pods were injured apparently by the readiness with which the organism attacked the remains of the sepals around the stem and causing a lesion that frequently involves the peduncle so that the food supply appeared to be cut off. That this was so could not be definitely determined. The beans certainly did not reach a normal size but it was impossible to say how great an influence the greenhouse conditions had on the plant.

Morphology of the organism.

The spores in a fresh culture are ovoid-cylindrical, straight or very slightly curved and hyaline. Under lower power magnification, many appear as two gullulate with some having as high as three or four guttules. Ellis described *Phoma subcircinata* as being two-nucleate.

The spores ranged on potato dextrose agar from 9.3 to 3.8 to 4.6 x 1.7 microns and averaged 6.48 x 2.62. Saccardo's were 6 x 2.5 and Smith gave them as 4-6 x 2-2.5. Ellis and Everhart report *Phoma subcircinata* as being 5-6 x 2-2.5 but Harter in making a study of the type material states that he found the spores to average 7,2x2.88. Harter also finds a range in size of the spores on various media.

The spores from old cultures are very different in appearance and vary from the shortest that are reported from fresh cultures to spores that are 17 microns long. In old cultures there seem to be two types of spores, one being the same as reported for the fresh culture and the other is darker, thick-walled type, much wider and filled with guttules or oil drops. In one or two cultures these large heavy walled spores are constructed in the middle and appeared as if septate.

The spores germinate in from 12 to 24 hours in agar and sterile water, though germination is generally very poor in the latter. A very noticeable feature of the germination of the spores is the tremendous increase in size of many of the spores which apparently occurs at the same time as the germ tubes are developed. In hanging drops of agar planted with spores of the average size, germinating spores became nearly round and 17 microns long and 14 wide. This swelling was not so prominent a feature in sterile water cultures though in that medium they have been measured up to 12 microns wide. A few were measured on the plants shortly after they had germinated but these had only increased slightly. Spores that do not germinate or germinate very slowly do not appear to increase in size. One lot of spores placed in a watch glass in ste-

rile water did not germinate to any extent. These examined a week later were found to contain a number of the larger thicker-walled spore which had become septate. The spores germinate first by one germ tube which is generally followed by a second from the opposite pole. This is sometimes followed by a third from the side. Germination may be slow and the developing germ tube may look like a secondary spore for a while. The germ tube becomes septate very early and also soon branches.

The spores are borne in pycnidia that vary greatly in size, 75 to 100 microns being the size of the smaller. The pycnidia on potato dextrose and all other media that is especially favorable for growth appear as if multi-ostiolate but it is considered that this is due to a coalescing of the pycnidia which are very numerous during their formation as sections cut through a developing colony show that this is quite possible. On colonies that are on a rather unfavorable substratum the pycnidia are far apart and there is generally only one ostiolum. The larger of the pycnidia measured 175 microns in diameter. The pycnidia are very delicate as the walls are only made up of two to four layers of thick walled, slightly darker cells that form a pseudo-parenchymatous tissue. Old pycnidia may become nearly black but the immature ones are as a rule translucent. This seems to depend on the substratum for on some media they are very difficult to see; the pink mass of spores in the centre with the dark ring of cells around the ostiolum being all that could be easily seen. In all but the very black pycnidia the ostiolum showed as a ring, but on sectioning pycnidia it was seen that it really is a short neck made up of cells similar to those in the walls and 5 to 6 microns long. As the spores mature in the pycnidia they are forced out in a pink mass. In cases where the pycnidia are on the surface of the substratum they ooze over the surface and give the colony the same appearance as that of a heavily sporulating colony of *C. lindemuthianum*. Where the pycnidia are embedded in the substratum the spores are forced out in any direction and the result is that a colony that is some three weeks old has little pinkish masses of spores forced down into the medium from the bottom of the colony.

The mycelium is variable in diameter, some being 11 microns wide with cells 15 to 30 microns long. Such mycelium branches and rebranches until it is of a fine distributive nature at the edge of the colony. The cell contents are hyaline and contain large oil droplets or vacubles which are more prominent as the colony ages. The pycnidia are placed in the normal colony in an indefinite manner There is no sign of a stroma only a few strands of dark mycelium growing around each pycnidium. In a colony that grew on a very unfavorable medium, and in another on potato dextrose agar at 14° C, the pycnidia were formed in branched radiating rows towards the edge of the colony as though following some special strand of mycelium. A few hanging drops of agar were left after one of the germination tests and on being examined later it was noticed that three small pycnidia had developed.

Appearance in pure culture.

The colony starts as a few radiating stands of white mycelium and shows clearly in from two to three days after the plate has been poured. The colonies

grew at the average rate of 6.3 mm. a day for the first six days after becoming apparent to the naked eye. This organism apparently has a wide range of temperature requirements. One fairly extensive test gave the best growth at a temperature that was fluctuating between 16° and 19°. A later test with more constant temperatures gave the most rapid growth at between 20 and 21° C. These are only an indication, however, as the incubators are in constant use for culturing other organisms and the opening and closing makes it impossible to keep the temperature constant. Good growth has been obtained at temperatures ranging from 15 to 23°C. At 26°C and over the rate of growth declines very rapidly. Some growth was obtained at 12°C, scarcely any growth at 28°C, and at 33°C growth of the organism was inhibited quickly.

As the colony develops on potato dextrose agar, it takes on first a reddish shade that gradually darkens and becomes olivaceous black. The change in color appears to be almost entirely due to a change in the color of the walls of the developing pycnidia which are very abundant. On some other agars this dark color is not so evident. Similar characteristics show an oatmeal agar.

On an agar made from the stems of beans after the juice had been removed the characters were much the same but on the agar made with the juice the reddish color was the most prominent feature.

The appearance of the colony varies with the environmental conditions, a high temperature giving a black stroma-like colony and a low temperature giving a thick dark olive-colored colony. Colonies moved into the laboratory from a dark incubator proved to be sensitive to the light as the pycnidia formed in rings. This zonation was evident in a colony grown on cornmea in the laboratory. The colonies show the spores, at the end of four or five days after culturing, as pink masses on the surface.

The colonies of this organism bear a striking resemblance to cultures of *C. lindemuthianum* that were being grown at the same time especially as to the pink masses of spores and the dark appearance of the colony. The pycnidia also bear a resemblance to the small sclerotia that are developed in the Colletotrichum cultures.

Artificial Inoculations.

These have been made at various times throughout the late winter and early spring on seedlings, plants in flower, and on plants where the pods were half formed. Inoculations were made by spraying on the spores with an atomizer or by placing a few drops of a spore suspension on the leaves. In all the experiments the conditions were the same as for inoculations with *C. lindemuthianum* some of which were also being carried on at that time (moist chamber for 48 hours at a temperature of 70F.) Smith in his inoculation experiments used a medicine dropper and left the plant under a bell jar for from 3 to 10 days. Good infection was obtained in two days though it possibly might be improved if left a little longer, especially if it means taking them out into a dry atmosphere at the end of the 48 hours. The best infection was obtained

on plants that were flowering, then those with half grown pods and lastly seedlings. The lesions were generally noticeable in from five to six days after inoculation as brown flecks that slowly developed and took on the characteristic color for the part infected. It was found impossible to distinguish between the ear y stages of this disease and anthracnose. Special attempts were made to get infection upon the full grown pods. They were placed in a spore suspension for from 48 to 70 hours and this failed. The epidermis was rubbed to remove the trichomes but without result. An attempt to get infection with spores in a dilute agar gave very confusing results as the checks also gave a browning of the epidermis like a lesion.

A brief study of the method of infection indicated that infection takes place through the more unprotected parts of the plant and in one instance what looked like infection through a stomate was observed. The tendency of the disease to develop around tender parts and around the old wounds from the dropping of the cotyledons would make it seem that it needed a break in the epidermis to establish itself readily.

The organism was reisolated repeatedly from the lesion, the affected tissue being first externally sterilized.

Summary and conclusions.

I. An organism isolated from a bean pod secured from Annapolis county, Nova Scotia, apparently infected with *C. lindemuthianum* is temporarily considered as being *Phyllosticta phaseolina* Sacc. and distinct from the conidial stage of *Diaporthe phaseolarum* (C. & E.) Sacc. commonly considered as *Phoma subcircina a* and which primarily causes a pod spot of lima beans.

II. The organism seems to agree very close'y with the descr'pt'on given by Smith of Phy losticta phaseolina but further work is necessaey actual y to dete mine by comparative cultures whether the present isolation is essentially *P. phaseolina.*

III. The organism has already been reported by Dearness from Canada as occurring on *Phaseolus parennis.*

IV. It has not been possible to determine its economic importance and the disease has been studied only from articificial inoculations on *Phaseolus vulgaris* in the greenhouse. Under such conditions it is important because of the injury to blossom.

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NOTE.—Since this paper was submitted for publication Dr L.L. Harter, to whom a culture was sent, writes as of June 15, 1925. "It resembles very closely the organism which I have isolated and studied frequent y from material collected from various parts of the United States."

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THE INSPECTION OF IMPORTED PLANT PRODUCTS AT MONTREAL

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The item "plant products" as you are aware covers a very large proportion of the goods arriving in Montreal from foreign countries, the chief of them which we inspect are nursery stock, vegetables, fruit, cut flowers, grain, lumber, coffee, unground spices, nuts, and broom corn.

In 1923, the regulations governing the inspection of plant products imported from foreign countries were revised on the recommendation of the Destructive Insect and Pest Act Advisory Board, Ottawa, and were brought into effect on September 1st, 1923. These regulations were passed in order to assist in preventing the introduction of foreign pests into our Dominion. The proverb "prevention is better than cure", is well exemplified by the foreign pests that have already entered our country and are costing thousands of dollars each year by their ravages, as well as for the spray material used in their control. Our worst insect pests today are nearly all of foreign origin. The European corn borer, which came from Austria or Hungary on consignments of broom corn I think, is undoubtedly one of our worst pests; it is steadily marching on and spreading rapidly in Ontario.

Other important pests which are worthy of special mention and which have been imported, due to our close proximity to the large agricultural country to the south are the brown-tail moth and the gipsy moth, the latter of which has already cost the United States millions of dollars in an endeavour to control, and which we hope will not get a foothold in Quebec.

It may be of interest to you to know how we enforce or carry out the Regulations at the port of Montreal, in order to prevent the introduction of further pests.

Our staff consists of four inspectors and a stenographer; we are located in the Customs building at the foot of McGill Street near the docks, which is an ideal location for our work.

I think Government regulations are similar to all big business undertakings, that is, in order to make them successful, it is essential to receive the fullest co-operation from all those whom they may concern. We have to depend very largely on the co-operation of the steamship officials, and Customs officers, in locating our consignments for inspection.

The steamship companies are very courteous and permit us to look over the ships' manifest, which is a document with an itemized list of the boat's cargo, for all points in Canada, the United States and other contries, so that we know excactly what is coming in from foreign countries *via* water.

We have a much harder task to keep track of what is coming into the country *via Rail*, as our railway systems have not yet managed to make up a manifest for each trainload of produce arriving in Canada and I do not suppose such a manifest would be of very great help, as we have a very long border line. These cars are switched at the border and we would need a very large staff if we had to place an officer at each of the border stations. The transportation companies at present have a separate manifest for each car, so that the best we can do at Montreal in regard to the rail shipments is to concentrate on produce that clears customs at Montreal. The bonded shipments for points outisde Montreal go through to destination without being intercepted by us. Nursery stock not arriving at St. John, N. B. but at other seaports along the Eastern coast of North America is bonded on Montreal or Niagara Falls for inspection and is intercepted by us.

All invoices of plant products that clear customs at Montreal, must be certified by one of our staff before the entry is passed. This is an easy matter for the customs brokers, as we are located in the customs building where they pass their entries, so that we have a record of all plant products for the port. We are entirely dependent on the customs officials to block any entries of plant products that have not been certified by one of our staff. A list of plant products has been isued to the chief checker so that they are always on the watch for such shipments.

When not busy with the inspection of nursery stock an inspector visits the railway express sheds where the fresh fruits and vegetables arrive each morning from the United States.

I believe that it is almost as important to inspect vegetables and fruits for insects, as it is plants; although the inspection of nursery stock receives special attention; and rightly so, as here we might have an insect lurking, waiting for its host plant to put forth its foliage so that it may feed upon it in the spring, and lay its eggs, and thus start an infestation.

The Regulations covering the importation of nursery stock are very strict and now that they have been in force for over a year, I think there are very few shipments from countries other than the United States which escape inspection by one of the members of the Department.

During last summer, it was found advisable to permit the importation of nursery stock through the mail from all countries other than the United States, as people were handicapped who wanted to import nursery stock in small quantities. The minimum freight and express rates on small quantities were so high, that the transportation charges were perhaps in some cases, five times the actual value of the goods. In order to cope with this matter, a new clause was inserted in the Regulations permitting the importation of nursery stock through

the mail on the condition that the importer have a'l his parcels ordered from countries east of Canada, addressed in care of the P ant Inspector, Montreal; and all parcels ordered from countries west of Canada addressed in care of the Plant Inspector, Vancouver. Consequently al' parcel post shipments arriving in Canada must be inspected either at Vancouver or Montreal.

One of our inspectors visits the post office the first thing every morning, inspects the parcels and re-addresses them so that they proceed to final destination with as little delay as possible.

Nursery stock arriving at the port of Montreal *via* boat is nearly all inspected at the docks, unless the Department has a local inspector at the final po nt of destination where the consignment is billed to; in that case the goods proceed to destination for inspection.

Navigation at the port of Montreal opened for the season o 1924, at the beginning of May, and closed at the end of November. During the period, 500 calls were made by boats carrying cargo to Montreal. All these boats were liable to have some kind of plant products on board, which would be subject to inspection under the Regulations of the Destructive Insect and Pest Act.

We also met most of the passenger vessels last season and inspected any plants that passengers were carrying with them, or packed in their baggage.

We are kept very busy in the fall at Montreal, attending to importations of nursery stock. In the spring most of the nursery stock is shipped by way of St. John.

Last fall as many as 7,000 cases of nursery stock arrived in one week, but this was exceptional Most of the cases were bulbs; time did not permit our opening every box, so we opened one box under each ma k, and if it was found to be in good condition, the other boxes under the same marks were "passed".

Quite a number of pests were intercepted during the past year, most of them being insects that are already present in Canada. One ser ous pest taken was an egg mass of the gipsy moth on a consignment of azaleas from Be'gium. This case carried the Belgian certificate of inspection so that it goes to prove that nc matter how careful the inspector may be in the county of origin, occasional y a pest will be m ssed, and this necessitates the re-examination of the plants on arrival at destination.

The following is a summary of the nursery stock which was inspected at Montreal during the past year (1924):

Fruit Trees	Small Fruits	Ornamentals	Roses	Fruit Seedling	Ornamental Seedlings	Bulbs	Greenhouse Plants	Roots
427	674	128,457	76,518	2,430	5,000	4,754,463	26,629	284,673

Total packages	8,109
Total value	$ 409,022.50

INSECTS OF THE SEASON IN SOUTHERN QUEBEC FOR THE YEAR 1924

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Cutworms.

Cutworms were not so numerous as in 1923 and the damage effected therefore was unimportant. Some individual cases of infestation were reported. A number of the growers have learned a lesson from past experiences, and they scattered poisoned bait just as soon as the first injury was noted, this method giving control in all cases without exception. The red-backed cutworm (*Euxoa ochrogaster* Gor) was the most important species around the Hemmingford District.

Cabbage Maggot. (Hylemyia brassicae Bouche)

The little white eggs were to be found clustered around the young plants about the third week of June, which was a week later than last year. Shortly afterwards the young cabbage plants began to wilt and die. From the number of plants at which eggs were found the infestation seemed to be serious, but, due to the lateness of the season and the good start the cabbage plants had made before the appearance of the insect, the injury was considerably reduced, Some gardens in the Hemmingford district had 50% of the plants destroyed.

Onion maggot. (Hylemyia antiqua Meig.)

The onion maggot was more prevalent than last year, and in some localities the loss to seedling onions was over three times that of 1923, but in other places the loss was somewhat reduced. Small tin pie plates containing a bait made by boiling ½ oz. Sodium arsenite in 1 gal. water and adding 1 pint cheap molasses, with excelsior for the flies to light on should be placed in the onion fi lds to control this pest. Gardeners still persist in delaying the placing of the pans until the fly has commenced to lay eggs, whereas they should be distributed when the seedlings are about 1½ inches high and before egg-laying has commenced.

Potato beetle. (Leptinotarsa decemlineata Say.)

As in the past this pest was present in all districts where potatoes are grown but the infestation was not very serious.

Beet leaf-miner. (Pegomyia vicina Lint)

The beet leaf-miner severely injured a large percentage of the leaves of beets in all districts visited. It was present more especially in the Montreal district and on one 2-acre field 80% of the leaves were infested. The eggs are laid on the underside of the leaves and the maggots bore into them and eat out

mines between the upper and lower epidermis. This injury to the leaves decreases the size of the root crop, and if grown for seed, the quantity of seed produced is often materially lessened by the partial defoliation of the plants.

Diamond-back moth. (**Plutella maculipennis** Curtis)

On August 26 a piece of late sown turnips in a Montreal market garden was completely eaten. On going through the patch but few cabbage worms and still fewer cabbage loopers were seen. However, there was a large quantity of very active larvæ nearly one half inch in length. These were identified as larvæ of the Diamond-back Moth, which occasionally become troublesome.

White grubs. (**Lachnosterna** spp.)

The injury from white grubs was light in most of the infested areas in 1924 but they did enormous damage in 1923. A big flight of June Beetles is anticipated this coming May and June and if such a flight occurs serious damage is to be expected in 1926. Thus the farmer should begin to plan his rotation so that the least susceptible crops will be grown on infested land in 1926. A repetition of last year's enormous damage may be averted by practising a proper rotation.

Raspberry cane borer. (**Oberea bimaculata** Oliv.)

The Raspberry Cane Borer was very bad in the area south of the St. Lawrence River this year. A considerable amount of the two year wood exhibited serious borer injury. There was a large number of eggs laid this year and it is predicted that where cutting out was not practiced there will be considerable damage done.

Clover head weevil. (**Tychius picirostris** Fab.)

In the Quebec Society Report for 1915-16, Dr. DuPorte reported this insect as doing considerable damage to red clover in the summer of 1915. He also stated that the insect was present in previous years but not in sufficient numbers to be of any economic importance. This year we have to report this insect as being abundant in the red clover heads at Covey Hill, Que. As many as 6 to 8 weevils were collected from a single head. The heads were dark brown in color and withered in appearance.

Plum curculio. (**Conotrachelus nenuphar** Herbst.)

This insect was not injurious in any of the fruit districts this year. Many orchards were visited but very few adults were secured.

Apple curculio. (**Tachypterelus quadrigibbus** Say.)

The apple curculio was first observed in the apple trees of June 3, increasing from this date on until July 14. The new brood of adults first appeared on

July 23. In unsprayed orchards this pest punctured as high as 50% of the fruit, but in sprayed trees the injury was very much less. With but one exception this insect was the worst pest of apple this year.

Codling Moth. (Carpocapsa pomomella L.)

This insect has greatly increased during the past few years and this year some unsprayed trees showed as high as 40% infestation. The injury has practically all been of the "sideworm" type.

Bud moth. (Tmetocera ocellana Schiff.)

This early spring insect was not troublesome to any extent. In some orchards it was more prevalent than in others, but where orchards were carefully sprayed at the correct times this insect was almost entr ly absent.

Aphids.

The orchards in Quebec are surprisingly free from these small but trouble some pests, and nicotine sprays are not necessary. Aphids,however, give some trouble on nursery stock, and the trees have to be carefully watched for this pest.

Apple maggot. (Rhagoletis pomonella Walsh).

Probably the most serious pest of apples in the Hemmingford and Covey Hill districts is the apple maggot. July 15, usually, the flies make their appearance, but this year the first fly was observed on July 9, which constitutes a Quebec record in all probability. In orchards treated for this insect there is a great reduction in the infestation, but in untreated orchards 100% loss has been observed and reported. Ent. Circ. No. 28, of the Entomological Branch, Dept, of Agric., Ottawa, deals with this insect and its control in Quebec.

Fall webworm. (Hyphantria cunea Dru.)

Towards the end of June eggs of the fall webworm were laid, and shortly after this the webs of the caterpillars could be seen especially in apple trees. There was a considerable number of webs this year particularly on the unsprayed trees. The webs covered a considerable area by August 20, and the webworms mostly in the third instar, were feeding vigorously. Any orchard sprayed for apple maggot is not likely to be troubled with this pest, because the spray is applied just about the time the young webworms are hatching and before they commence to make the web.

Elm leaf miner. (Kaliofenusa ulmi Sunde.)

In certain district near Hemmingford this recently imported pest was observed. It was noticed doing considerable damage to elms at Covey Hill and

serious damage at Franklin Centre, Stockwell, and Mt. Johnson. The injury caused by this insect is as the name implies in the elm leaf. Mines somewhat similar to beet leaf miner work are made, and in badly infested trees practically every leaf will have a blotched appearance.

The maple borer. (Plagionotus speciosus Say.)

For a number of years this insect has been doing damage to the sugar maple in this and surrounding distiets. Many trees in the maple woods are dead or dying directly or indirectly from the injuries of this insect.

Caterpillars feeding on leaves of oak.

During the month of August there was an infestation of caterpillars feeding on the leaves of ask, *Quercus alba* Linn. Defoliation was quite severe, for the bare appearance could be noticed a considerable distance from the tree. The caterpillar was a species of *Anisota*, probably *senatoria.*

Maple leaf cutter. (Paraclemensia acerifoliella Fitch)

In the sugar maple bushes in the Hemmingford and Covey Hill districts a severe infestation of the above insect occurred this year. In one bush practically every leaf on every tree was marked with one or more of the peculiar ring-like patches. These patches were the work of the larvæ of *Paraclemensia acerifoliella.*

Slugs

Gardens in Montreal West were very materially injured by slugs which were present in very large numbers.

Potato Flea beetle (Epitrix cucumeris Harr.)

This insect was quite numerous on potatoes and tomatoes in several districts. This and allied flea-beetles are not taken seriously enough by the growers, because they really do very considerable injury to the young plants.

Imported cabbage worm. (Pieris rapae Linn.)

Present in medium numbers wherever cabbages were grown south of the St. Lawrence River.

Peacock fly or Sunflower maggot. (Straussia longipennis Wied.)

One large field of sunflowers near Lennoxville had 99% of the sunflowers infested with the larvæ of this fly by July 31 and reports of serious injury were received from Richmond, Milby, Huntingville and Cookshire. The value of the crop is very considerably reduced by its attacks and the growing of this crop is being discontinued by many farmers owing to the attacks of this insect.

Cigar case-bearer. (**Haplotilia fletcherella** Fernald.)

This insect is very destructive to apple foliage in the region of LaSalle and along Lake St. Louis. In the fall the twigs were almost covered in many instances with the overwintering cases.

Cranberry rootworm beetle. (**Rhabdopterus picipes** Oliv.)

By July 12, an apple orchard at Rougemont, Que. was severely injured by this insect. One half the crop on two thousand trees was severely eaten and the leaves were also considerably eaten. This is the first record of this insect doing serious injury in Canada.

Round-headed apple-tree borer. (**Saperda candida** Say.)

Continues to be injurious to apple trees in many sections of the province. Abbotsford, Rougemont, Hemmingford districts and Missisquoi county are the places most seriously affected.

Currant spanworm. (**Cymatophora ribearia** Fitch.)

A few cases of severe injury were noted at Ste. Anne's and Beauharnois on both wild and cultivated varieties.

Buffalo tree-hopper. (**Ceresa bubalus** Fabr.)

Numerous scars were found on young trees in the Hemmingford district. The importance of attacks from this insect has not been sufficiently emphasized because when the scars are numerous the functions of the bark are interfered with In consequence, the vitality of the tree is materially lessened and the tree becomes sickly and often dies.

Apple Tent caterpillar (**Malacosoma americana** Fabr.)

It was found mostly along roadsides, fences, etc. especially on wild cherry. There was an increase of 100% in Central Quebec over 1923 but it was held in check and developed very slowly up to June 20 owing to the cool, wet weather.

Apple-tree bark-miner. (**Gracillaria elotella** Busck.)

Serpentine mines in the epidermal bark of young apple trees was noted in several orchards near Hemmingford.

Gipsy moth. (**Porthetria dispar** L.)

Several hundred egg masses were found by the Gipsy Moth Scouts in the Belle Vallée about ten miles east of Hemmingford. This is the first time this insect has been collected in any numbers in Canada.

Case-making clothes-moth.—(**Tinea pellionella** L.)

This household pest is common in many places in Quebec and has caused very serious losses in and injuries to clothing and other household goods. It is much more serious than is generaly realized.

NOTES ON PLANT DISEASES IN QUEBEC DISTRICT FOR 1924.

Omer Caron, Botanist, Dept. of Agriculture.

Cereals.

The seed disinfection campaign started a few years ago has brought about very satisfactory results. We have no complete and accurate statistics as to this but the dealers give us the information that they are selling more and more formalin for this purpose. Although we firmly believe in the efficiency of the copper carbonate treatment for oat disinfection we have not yet tried to introduce this method since it is always dangerous to invite the farmers to change their methods too often. With us the formalin dry treatment gives good results. Formalin is a cheap material and when the directions for its use are scrupulously adhered to it does not materially affect the germinative power and the strength of the seed.

Potatoes.

During the season of 1924 many complaints have been received from Eastern Quebec regarding the Black leg disease. On account of the high percentage of said disease in fields some producers have been refused certification for their tubers.

It sometimes happened that the damage attributed to Black leg was rather caused by the Sclerotium disease of potatoes. We have made cultures on potato-dextrose-agar with material kindly supplied by Mr. H. N. Racicot and we have thus obtained an organism identical with the one discovered by Mr. O. W. Lachaine in New-Brunswick a few years ago. It may then be stated that the Sclerotial disease is now established in the Province of Quebec.

Small fruits.

We must mention here a strawberry disease which seems of importance for it is generally widespread around Quebec city. It is a sort of crown-rot. Following a dry spell the leaves turn yellow, wrinkle, wilt and the plant dies within a couple of days. When pulled away it is generally observed that the rootlets are rotten and the interior of the crown is brownish. The Senator Dunlap is the most seriously affected variety. Though rather common in the United States this disease is not considered a serious pest, probably because it never causes as much damage with our neighbours as with us, where the percentage

of diseased plants ran as high as 50%. The fact that it attacks isolated plants or frequently two plants united by runners induced us at first to believe it was bacterial in origin. The exact cause of the disease still remains im perfectly known.

Last Summer we sent to our field horticultural inspectors a questionnaire which they were asked to fill out. We have also personally inspected a large number of fields and in comparing our notes with the data received from the field men a certain number of facts was noticed which may be reported here.

1) The disease attacks the strawberry plants specially after the second wintering;

2) it is particularly serious on dry sandy soils well exposed to sunshine in Summer and not covered by snow in Winter;

3) a dressing of nitrate of soda and even of manure appears to have a preventive effect;

4) the disease does not develop to any extent in weed infected stands nor in plantations, sheltered during Winter.

These observations though not absolute have been repeated in a sufficient number of cases to make us believe that they are of some significance. Until we have had an opportunity to complete our observations we are of the opinion of those who claim that this disease is a physiological one. It would therefore be a consequence of an uprooting due to the frost. It is supposed that on account of the action of the frost the roots are broken. When the next Summer drought sets in, the plant lives for a while on its own supplies but when no more water is available it dies out. In such a case, as the soil itself is deprived of water, the formation of new rootlets is made impossible. We have not quite given up the bacterial theory but many more observations would have to be made before we are in a position to prove it.

Vegetables.

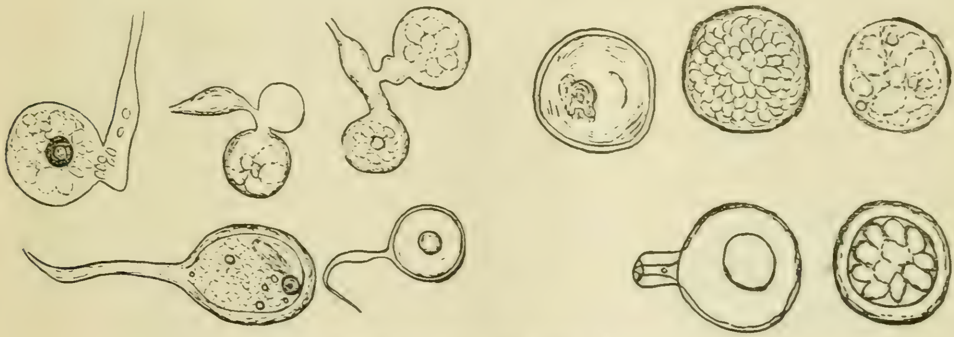
Last Summer we saw at Joliette a field of cauliflowers infected by a disease which forms blackish blisters on the under side of the leaves. This caused the affected plants to rot and the damage were already considerable when we happened to visit this field towards the middle of August. With such serious infection, there was no time to be lost and we at once urged the use of a 4-4-40 Bordeaux mixture with the addition of about half a pint of molasses per three gallons of mixture and one half ounce of soap for the same quantity. According to the report received later on from the producer the result wasvery satisfactory.

Some leaves of the diseased cauliflowers placed in a moist chamber grew in a few days an organism bearing macrospores belonging to a species of **Alternaria,** probably **Alternaria** (**Macrosporium**) **brassicœ** Berk.

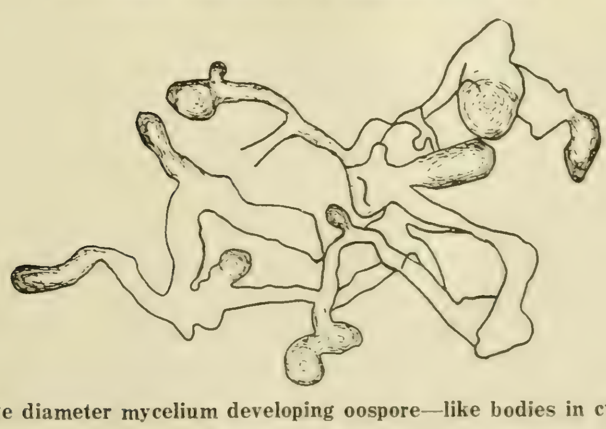
OOSPORE-LIKE BODIES IN CULTURES OF PHYTOPHTHORA INFESTANS

By H. R. Angell.

How the fungus causing Late Blight of Potato overwinters is a problem that has, we feel, not been altogether solved. The general infection that suddenly appears in fields in the Fall when weather conditions are favourable has not yet been satisfactorily explained and that there is some other means of overwintering than as mycelium in diseased tubers is a possibility. In the seventies Worthington G. Smith reported that he had found oospores in diseased tubers, but DeBary disproved this. Sadebeck later showed that they were those of *Pythium Equiseti*, while Massee expressed the opinion that they were Chlamydospores of a Fusarium. Smorawski in a single instance found bodies that he called immature oospores. Clinton, in 1910, reported that he had in pure cultures of Phytophthora infestans found perfect oogonia, antheridia and even oospores. Jones at Vermont, at the same time, announced that he had found in pure cultures immature bodies apparently of an oogonial nature but whose identity was doubtful.



Individual bodies showing types of structures



Large diameter mycelium developing oospore—like bodies in culture.

With the object of finding out something more about these bodies and under what conditions they are produced the present investigations were undertaken. About the middle of October 1924 the writer collected from the experimental plots of the Botany Department of Macdonald College some potato leaves infected with *Phytophara infestans*. Attempts at the isolation of the organism on ordinary laboratory media (potato, potato-dextrose, rice, cornmeal) failed owing to the rapid growth of saprophytic organisms and the unsuitability of the media for *P. infestans* At the same time, however, the precaution was taken against failure by placing bits of leaf tissue from the edges of the diseased are s on slices of potato tubers cut under sterile conditions. These in moist chambers yielded a vigorous growth of the desired fungus, and after a few transfers to fresh slices of potato it was possible to o)tain mycelium that was purely *Phytophtora infestans*. This was first transferred to bean agar, but the resulting growth was very slow and poor. Oatmeal agar, 50 g. oatmeal, 20 g. agar, 500 cc. water, made without straining and sterilized at 17½ lb. for 30 min. proved a most satisfactory medium. Excellent growth over the whole surface of the slant was obtained. In making transfers care was taken to use a large quantity of the inoculum, including some of the substratum. The cultures were kept in a closed cupboard in the laboratory where the temperature averaged about 18oC. Inoculations of potato plants with spore suspensions from one of these cultures resulted in typical lesions of late blight. Sliced tubers inoculated with the mycelium after it had been in culture for four months developed an excellent surface growth. After about six weeks material from the pure cultures was examined carefully under the microscope, and revealed the presence of a small number of brown oospore-like bodies. Only two or three tubes, (one especially) out of about 20 showed these structures. From the best of these, transfers were made to another series of tubes and these were kept for three weeks in a humidifier in a closed cupboard. The agar used in making these cultures was strained oat-meal (50 g. oatmeal, 20 g. agar, 1000 water). Growth on these was just as good as in the others, and at three weeks when the first examination was made the same brown oospore-like bodies were found. Practically every tube yielded them in greater or less quantity. Whereas in the first cultures they were found singly and only towards the upper and thinner portions of the slant, in these tubes they were everywhere, and not only singly, but in twos, threes, fours and more. They were borne terminally on much-branched, thick, light brown, differentiated, clumped masses of mycelium. Only in two instances were antheridia found and the oospores were apparently still immature. A few attempts at germinating these bodies have been made, but unsuccessfully. Tubes were placed outside during January and left to freeze. It was hoped that the mycelium would be killed and the brown bodies remain uninjured. From this material transfers were made to fresh oatmeal agar and to potato slices. No growth, however, resulted. Hanging drops containing three or four bodies isolated from fresh cultures also gave negative results. In another case they were dried over sulphuric acid for 48 hours,

and then placed in a hanging drop to which was added a small bit of a potato leaf. After some days some changes were observed in the protoplasmic contents. In two cases spherical hyaline bodies suggestive of zoospores were seen moving inside some of the bodies. They were carefully watched but nothing further happened. Apparently it was but streaming of the protoplasm.

Interesting results were also obtained by growing the fungus in liquid extract of oatmeal. Large pieces of inoculum and substratum from agar slopes were placed in Erlenmeyer flasks containing the liquid 1-8" deep. Care was taken not to drown the inoculum. Scant surface, but a large amount of sub-surface, growth in the medium was the result. The amount of differentiated mycelium bearing the oospore-like bodies was very marked. Time did not allow making careful search for antheridia, but later further studies will be made.

The average size of these bodies taken from various cultures, solid and liquid, varied around 33u.

Stained sections of diseased potato leaves which were allowed to rot in moist sand showed many spherical bodies about 6u in diameter. The nature of these bodies is unknown. Attempts at infection of potato tubers and leaves with the rotten material failed.

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WINTERING OVER AND INFECTION OF PUCCINIA MALVACEARUM, MONT.

H. Hill, B.S.A.

This paper consists of a brief report of germination tests and inoculations made with the teliospores of *Puccinia Malvacearum* which had overwintered outdoors in Quebec on the stems and leaves of the hollyhock.

The purpose of the work was to determine the possibility of the organism living over the winter as a teliospore and germinating the following spring, causing infection of healthy plants.

History.

The organism is a uredinaceous fungus belonging to the so-called lepto-form; it has neither æcia nor uredinia, producing only teliospores. The teliospores usually germinate *in situ* as soon as mature to form promycelia with sporidia.

Work has been done on this organism by several investigators, including McAlpine, Massee, Plowright, Halsted, Daudeno, Eriksson, Taubenhaus. It is interesting to note that this is one of the organisms upon which Eriksson's mycoplasm theory is based. These workers in general agree that the fungus is carried over the winter. (1) As developing mycelium in the tender young leaves. (2) With the seed.

Plowright and Massee also suggested that the teliospores survive the winter on dead or decaying leaves. Daudeno attempted to solve this problem through actual experiments but obtained negative results. Taubenhaus conducted germination tests with teliospores which had overwintered out of doors and obtained germination on several occasions. Taubenhaus does not mention the percentage of germination obtained or the percentage of teliospores that had already germinated *in situ*; nor did he conduct inoculation experiments with healthy plants to determine if these spores were able to cause infection.

Morphology of Teliospores.

The teliospores are borne in knobs, composed of different maturity; the older spores possessing longer pedicils and extending to the outside of the knob or fascicle. The young teliospores are at first one-celled and are continually being formed even while old spores in the same sorus are in a state of germination. There is considerable variation in the form and size of the teliospores. The normal spore is two-celled, slightly constricted at the center and tapering towards both extremities. The normal spore is 53.8 microns by 15 microns with a range of 38 to 65 microns by 9 to 25 microns. One-celled mesosphores and three-celled spores may be also found. Taubenhaus reports also the occurrence of four -celled spores but they have not come under my attention. Both cells of the teliospore may germinate, sending forth promycelia; but as a rule germination is confined to the apical cell. The general type of promycelium is a long slender tube with the protoplasmic contents of the germinated cell collected at its extremity. After a short time the protoplasmic portion divides into four cells.

According to Taubenhaus the sporidia are formed in one of two ways. (1) The four cells of the promycelium may separate into free and independent cells. Each of these cells later sends out a little protrusion which elongates and swells up as the contents of the mother cell is gradually passed into it, and thus a mature sporidium is formed, which readily breaks away from the basidial cell and germinates. In the other type the four cells of the promycelium do not break apart but ea h sends out a little sterigma which gradually swells up until the sporidium is formed, into which the contents of the basidial cell is passed.

The sporidium is then abstricted and germinated. The latter form may be considered the normal type.

In my own germination tests observations of sporidia formation were practically lacking, due perhaps to the rapidity with which the process takes place.

The material which was used for my first set of germination tests and inoculations was procured on February 26 from a bed of hollyhocks situated in front of the Chemistry Building at Macdonald College. The material had been subjected to the full severity of the winter's frost. According to the college records the thermometer registered as low as—35 degrees Fah. during this period and the mean temperature for January-February was about 9 degrees F. These temperatures represent the average winter temperatures for the region so that the retained vitality of the teliospores could not be due to an unusually mild winter.

Various sori on different parts of the plants were first examined to determine, by means of the empty spores, the percentage of teliospores that had already germinated *in situ*. It was very difficult to arrive at any definite percentage as the spores in some sori were almost entirely germinated while in others as high as fifty per cent were still ungerminated. As an approximate determination I would say that about 75% of the teliospores had germinated before this date.

The ungerminated teliospores may be due to late infection in the fall, the teliospores remaining dormant in the winter and becoming mature in the spring; or due to the fact that the spores in the individual sorus mature at different times, the younger spores in some of the older sori may be immature when winter comes and may not mature until the following spring.

Teliospores were placed in water obtained from melted snow in Van Tieghem cells. Germination was noted in twenty-four hours. About twelve percent of total germination of the ungerminated spores was obtained.

Three healthy hollyhocks were inoculated by placing teliospores on the under surface of the leaf. The plants were thoroughly watered and placed under a bell-jar. On March 13 a single sorus was observed on each of the leaves infected. Permanent slides were made of sections through these sori and examined. Teliospores in different stages of maturity were noted. Material was also gathered at later dates up until the end of March. Germination tests and further inoculations were made.

Three additional plants were inoculated in a like manner, two of which became infected. On the one plant only a single sorus was produced while on the other plant a group of six sori were produced on the one leaf. It was noted that material collected during dry and warm weather would not germinate. Some of these sori were placed on the leaves of healthy plants in an endeavor to produce infection but success was not obtained due perhaps to scarcity of inoculum.

Conclusions.

The immature teliospores of *Puccinia Malvacearum* are able to withstand the severity of winter in Québec and germinate the next spring producing infection of healthy plants.

The percentage of teliospores which overwinter and the percent viable is very low so that the teliospores cannot be considered as the chief means of spring infection in Québec.

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ABSTRACTS OF CANADIAN PLANT PATHOLOGICAL LITERATURE.

A. W. McCallum.

The abstracts and references given herewith include the papers on plant pathology published in Canada during 1924.

Baribeau, B. Fletrissure et Pourriture de la Tige du Tournesol dans la Province de Québec. Sci. Agric. 3: 397—400. Fig. 1-6. 1923. — The symptoms of the wilt of sunflowers which has been noted in several districts in Quebec are described. Beans and turnips were also found affected. The sclerotia overwinter in the soil and remain viable for at least two years. The causal fungus is believed to be *Sclerotinia libertiana*.

Bisby, G. R. The Sclerotinia Disease of Sunflowers and other plants. Sci. Agric. 4: 381-384. Pl. 1. 1924.—In Manitoba sunflowers, and carrots and parsnips in storage are subject to severe injury by *Sclerotinia*. Alfalfa, red clover, soy bean, and sow thistle are also attacked. Sclerotia from sunflowers were germinated and the measurements of the asci and ascospores were found to agree with those of *Sclerotinia sclerotiorum*. From the fusions of hyphæ in culture from different hosts and from cross-inoculations it was concluded that but one fungus was present and that was *S. sclerotiorum*.

Brittain, W. H. Methods employed in recording results of spraying and dusting experiments in apple orchards. Sci. Agric. 4: 141—151. 1924.

Dickson, B. T. Saltation in the Organism causing "Black Dot" Disease of Potato in Canada. Trans. Roy. Soc. Can. (3rd series). 17 (Sect. 5): 123-128. Pl. 3. 1923.—In culturing the organism which causes black dot of potatoes two variants of the type form, one which produced conidia only and one which

produced both conidia and sclerotia, were encountered. In typical cultures sclerotia only are formed. The variants have been cultured throught ten generations without reversion. Several parallel cases are mentioned.

Dickson, B. T. Oat smut control experiments in 1923. 16th Ann. Rept. Que. Soc. Prot. Plants for 1923-1924: 77-79. 1924.—With a variety of hull-less oats the Cu So 4 dip was found to be the most effective of the several treatments used.

Drayton, F. L. Survey of the Prevalence of Plant diseases in the Dominion of Canada, 1923. Canada Dept. Agric. Exp. Farms Branch: 4th Ann. Rept. 1—125. 1924—Reports from every province are included. There is information concerning 333 diseases found on 102 hosts.

Eastham, J. W. Report of Provincial Plant Pathologist, Vancouver. 18th Ann. Rept. B. C. Dept. Agric. for 1923: 41-43. 1924.—Notes on root blight of seedling and heart rot of mature mangels which by some are said to be due to *Phoma betæ* and by others to unfavourable soil and weather conditions, white pine blister rust, and Colorado beetle.

Faull, T. H. Forest Pathology: In Report of Forestry Branch, 1923' Ann. Rept. Min. Lands and Forests, Ont. for 1922-1923: 197-207. 1924.—Red heart rot of balsam fir—a common and destructive decay of this species—is described and the cause attributed to *Stereum sanguinolentum*.—Six types of defective balsam fir and four of spruce are described and considered in relation to utilization as pulpwood.—The alternate stage of the fern rust (*Hyalopsora aspidiotus*) has been found to occur on three year old leaves of *Abies balsamea*

Fritz Clara W. Cultural Criteria for the Distinction of Wood-Destroying Fungi. Trans. Roy. Soc. Can. (3rd series). 17 (Sect. 5): 191—288. Pl. 1-12. 1923.—This investigation was undertaken in order to provide a laboratory method —based on cultural characteristics—to supplement the field methods—propinquity of fruit bodies and gross characteristics of decayed wood —used for the identification of wood rots. An introductory historical review of the study of wood destroying fungi, both in nature and in artificial culture, is given. Eleven of the common wood-destroying polypores and six different forms affecting balsam fir were used. In the case of the eleven fungi cultures were obtained from sporophore tissue and compared with cultures from decayed wood. For the decays of balsam fir cultures were of necessity secured from rotted wood. Later, two of these were identified on account of similarity to tissue cultures as *Poria subacida* and *Polyporus balsameus*. Cultures were grown in a non-illuminated incubator at 22oC. A number of synthetic and vegetable media were used but for diagnostic purposes potato-dextrose agar was found to be the most suitable. Most of the forms permitted a wide variation in growth conditions without a corresponding change in cultural characteristics. A key for the identification of the seventeen fungi studied is presented.

A distinct strain of *Fomes igniarius*—that obtained from poplar—was observed. Chlamydospores are reported in *Polyporus balsameus, P. borealis, P. schweinitzii,* and *P. versicolor.*

Gordon, W. L. Studies concerning injury to seed oats after smut disinfection. 16th Ann. Rept. Que. Cos. Prot. Plants for 1923-1924: 79-94. Pl. 1-4. 1924.—This work was carried on in order to determine the factors which cause injury to seed oats after treatment for smut. Three varieties of hulled and one of hull-less oats were used with several different treatments and variations of these treatments. The results obtained with each variety are described for each treatment.

Gussow, H. T. Plant diseases in relation to certification of seeds. 16th Ann. Rept. Que. Soc. Prot. Plants for 1923-1924: 72-79. 1924.—The importance of the dissemination of diseases by means of seed is emphasized and the lack of precise information concerning such diseases commented upon.

Gussow, H. T. Seed Potato Certification. 1—23. King's Printer, Ottawa 1924.—An address before the Select Standing Committee on Agriculture and Colonization outlining the origin and development of the present system of potato certification as carried on by the Dominion Department of Agriculture. Reference is made to leaf roll and mosaic, the standards for field and tuber inspection are given, and the possibility of utilizing potatoes for the manufacture of starch and alcohol discuss d.

Gussow, H. T. Wheat Rust. 1-25. King's Printer, Ottawa. 1924.—The economic importance of rust is pointed out and the salient features of the problem—barberry eradication, physiological strains, breeding of resistant varieties and methods of overwintering of uredospores are reviewed. The inadequacy of the present appropriation for the proper prosecution of the problem is emphasized and increases in the staff and facilities for carrying on this work are strongly urged.

Gussow, H. T. Report of the Dominion Botanist. Can. Dept. Agric. Exp. Farms Branch for 1923-1924: 1-53. Fig. 1-7. 1924.—The annual report of the Division of Botany dealing with the various phases of investigative work which have been carried on during the year at the central and field laboratories. Among others, there are sections devoted to forest pathology, potato certification, raspberry mosaic and leaf curl, cereal rusts, smuts, and root rots, and fire blight.

Howitt, J. E. A review of our knowledge concerning immunity and resistance in plants. 16th Ann. Rept. Que. Soc. Prot. Plants for 1923-1924: 9-24. 1924.—Some of the more important achievments in the production of disease resistant plants are recounted and the significance of the terms immunity, resistance, apparent immunity, apparent resistance, and tolerance is discussed.

While the causes for the three latter conditions are not very difficult to explain the reasons for immunity and resistance are very complex. The principal causes apparently are anatomical modifications and biochemical reactions. The writer believes that the future research on this subject will lie largely in the field of biochemistry. A very extensive bibliography is appended.

Kelsall, A. Dusts and Dusting in Crop Pest Control. Sci. Agric. 5: 37-51. 1924.

Maheux, Georges. Millardet—the creator of applied phytopathology. 16th Ann. Rept. Que. Cos. Prot. Plants for 1923-1924: 57-60. 1924.—A sketch of the work of this investigator to whom belongs the credit of improving and introducing to general use the solution which later became known as Bordeaux mixture. It is noted that the action of copper sulphate on fungi had been first recorded in 1807 by Benedict Prevost. In 1914 a beautiful monument in momory of Millardet was erected by the grape growers of France in the botanical garden at Bordeaux.

McCallum, A. W. Abstracts of Canadian plant pathological literature. 16th Ann. Rept. Que. Soc. Prot. Plants for 1923-1924: 145-147. 1924.

Newton, R., and W. R. Brown. Is the Apparent Winter-Killing of Sweet Clover and Red Clover a Result of Disease injury? Sci. Agric. 5: 93-96. Fig. 1-4. 1924.—White sweet clover which was thought to have suffered winter injury was found to contain black sclerotia and the injury is probably due to *Sclerotinia* sp. In red clover the indications are that this fungus is an important contributory factor to the apparent winter injury.

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